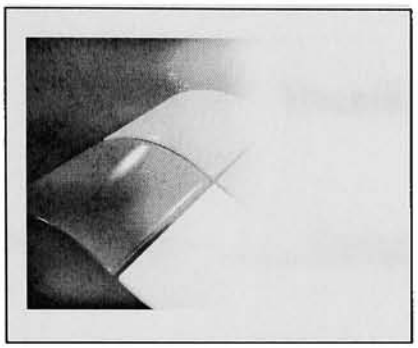
2004

Migration from Windows to Linux for a small engineering firm "A&G Associates"

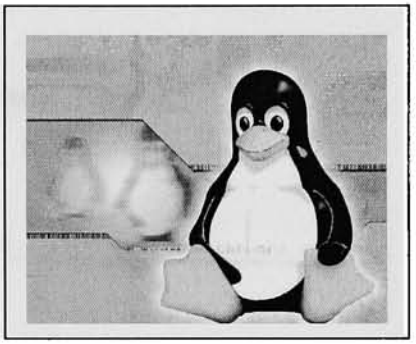
Trimbak Vohra

Migration from Windows to Linux for a Small Engineering Firm

"A&G Associates"



Windows



Linux

by

Trimbak Vohra

Thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Information Technology

Rochester Institute of Technology

B. Thomas Golisano College
of
Computing and Information Sciences

Date: December 2, 2004

Rochester Institute of Technology

B. Thomas Golisano College of Computing and Information Sciences

Master of Science in Information Technology

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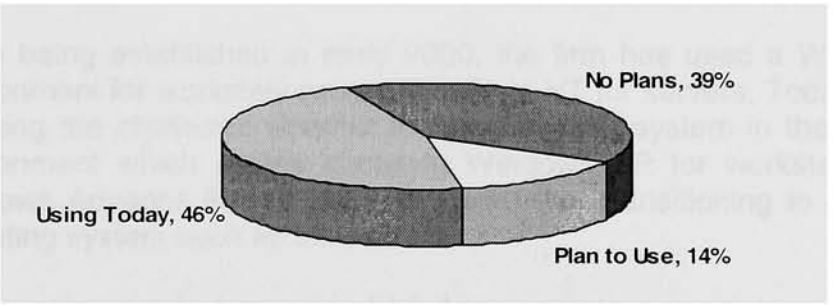
Abstract

The primary objectives of this paper are to complete a Masters Degree in Information Technology as required by Rochester Institute of Technology, Rochester, New York, and to assist a small engineering firm in evaluating the possibilities of migrating from Microsoft Windows to a Linux Operating System.

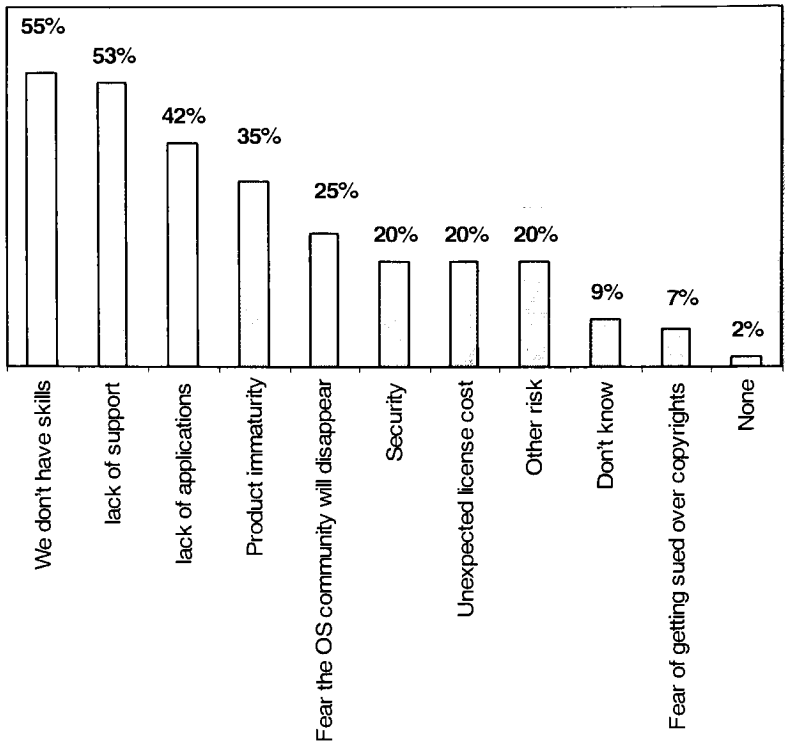
A recent announcement that Microsoft will limit support on some of their existing commonly used operating systems, along with their monopoly in the marketplace, will continue to allow them to sell licenses at high prices. These factors could force many companies to consider transiting to other operating systems which offer more support services and less expensive products.

Although there are several such providers, the low cost of Linux, its non-rigorous licensing agreements, high level of security, stability, and usability makes it the best non-Microsoft operating system option. A 2004 survey of 85 North American firms conducted by Forrester Research, Inc., confirms that the transition has begun. The survey showed that low acquisition cost was the primary reason why firms moved to Linux, followed by low total cost of ownership, and then by low hardware cost.

As of today the number of users or potential users of Linux are summarized below



Many firms are concerned about transitioning to Linux due to the fact that Linux is an open-source technology that has greater risks than Windows which the owner has to mitigate somehow. In reality there are many emerging companies which are providing 24/7 support to Linux just like Microsoft. The figure below presents the main concerns of firms planning to move to Linux.



The practical case used for evaluating transitioning from Windows to Linux is A&G Associates. The firm specializes in the design and construction management of water and wastewater treatment facilities. The firm's current local area network configuration consists of 4 servers and 50 workstations.

Since being established in early 2000, the firm has used a Windows 98 environment for workstations and Windows NT for servers. Today the firm is facing the challenge whether to upgrade their system in the Windows environment which entails choosing Windows XP for workstations and Windows Advance Server 2000 for servers or transitioning to a different operating system such as Linux.

The most important reason for A&G Associates to move to Linux will come from a cost savings opportunity between the Windows and Linux operating systems. Since Linux can be downloaded for free or a licensed CD can be bought for less than $200 dollars, it can be used on multiple computers, and it offers many free applications, the most cost-effective solution seems to be to purchase Linux.

The cost savings opportunities were based on three alternatives:

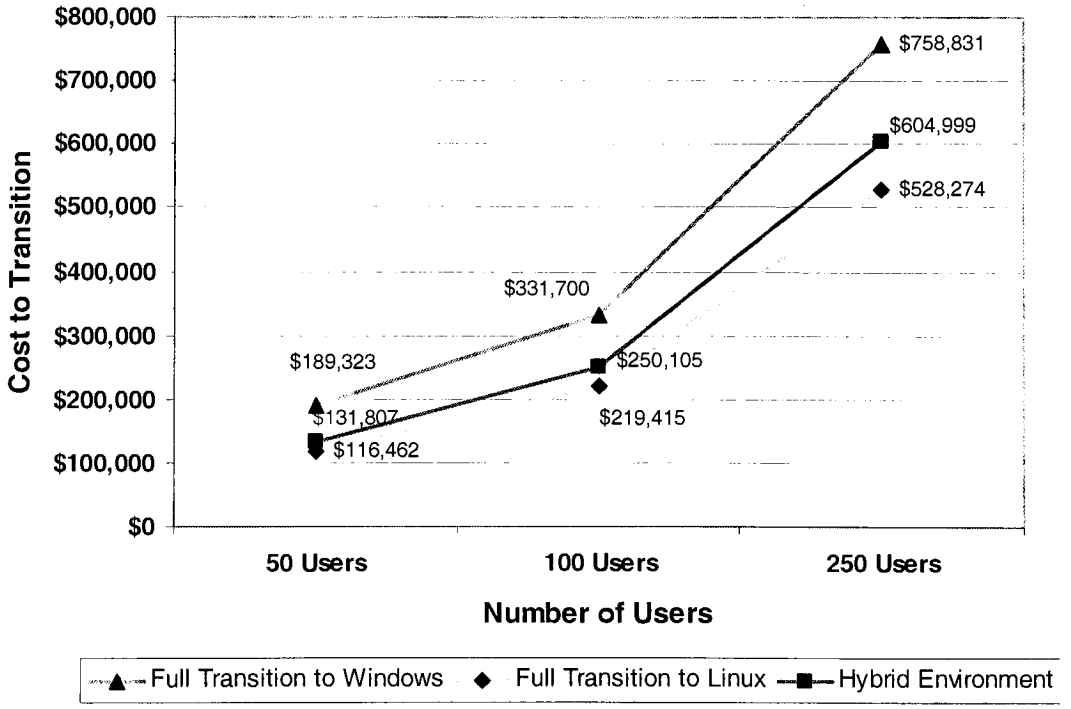
1. Full Transition from the existing Windows environment into the newest version of Windows for workstations and servers; or

2. Transition from an existing Windows environment to a Linux environment for workstations and servers.

3. Partial Transitioning (Option 5) from existing Windows environment to a new Linux environment for servers and majority of the workstations (35) and to upgraded Windows for 15 workstations

Partial Transition Option 5 takes care of the issue of running engineering applications on some Windows workstations and changing the majority of the workstations and all servers to Linux in order to obtain the maximum cost savings benefit. In this option, 15 workstations are upgraded to the new Windows XP Platform and all four servers and the remaining 35 workstations are migrated to a Linux Platform. The total cost for partial transitioning under option 5 is $131,807.

The total cost for transitioning the firm from Windows to Linux for A&G or a small firm with 50 to 250 employees and the associated total cost for full-transitioning to a new Windows version, a Linux platform, or to a hybrid environment such as "Option 5". The results is presented below



Based on the results of the study, the following conclusions were drawn that would help the firm make informed decisions:

- Making a full transition to Linux would limit the availability of engineering software compatible with Linux.
- The total cost of transitioning under the partial transition, Option 5, would be approximately $132,000, with approximately $12,000 in software costs and $98,000 for hardware; the remaining cost is associated with operating the system.
- Total cost savings of transitioning to Linux under the partial transition, Option 5, compared to a full Windows transition is approximately $58,000.

The following are the recommendations for A&G:

- The firm should consider transitioning to Linux but upgrade some workstations to the Windows XP environment in order to maintain the ability to run engineering applications, in accordance with partial transition, Option 5.
- Implementation of partial transition, Option 5, would provide cost savings of approximately $58,000 during the transition to the new operating system.

As Linux continues to provide its operating system at a more reasonable price, as more applications become available, and services such as 24/7 assistance and security become more reliable, the possibility that firms will move away from Windows toward Linux is inevitable. However, in the meantime, a partial transition can provide firms with greater flexibility and costs savings when compared to making a full transition to either the Windows or Linux environment.

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Introduction

1.1 General

1.1.1 Purpose of this paper

The primary objective of this paper is to complete a Masters Degree in Information technology as required by Rochester Institute Technology, Rochester, New York, and to evaluate the opportunity to migrate from Microsoft Windows to a Linux Operating System. This document will use a small engineering firm as a case study to assess the opportunity in making a decision during transition to a most efficient operating system for their desktops and server hardware. Also, this document can be used as a baseline for a starting company during the selection of an operating system for their network system including desktops and servers.

1.1.2 Why this paper

With the new Microsoft announcement of limited support on some of their common used existing operating systems, and their monopoly in the market giving them an upper hand to sell licenses at high prices could force many companies to transition to other operating systems. Due to the fact that Linux is similar to Windows and that the savings are potentially substantial and success rates are high, the transition process will be relatively easy to implement. This paper will attempt to answer the many questions and concerns raised during this transitioning.

As of today, the low cost of Linux, its non-rigorous licensing agreements, high level of security compared to Windows, stability and usability makes Linux the best non-Microsoft operating system option.

This research paper is a snapshot in time based on the available information to evaluate Linux as a replacement Operating System, and will have the enterprise architects view, developers view, user views, case studies and the risk associated in Operating System transition.

This paper will focus in the comparison between Windows and Linux in order to identify the advantages and disadvantages of each system. Also the financial consequences of a market under a monopoly controlled by Microsoft Windows and the fact that Linux is an emerging technology with potential for substantial savings for a company willing to transition to it or a new company during their selection of an Operating System .

1.1.3 Why transition to Linux

Strengths: Linux has unique characteristics and strengths. The technical progress is faster, and goes further because each time there is a version update/new release it does not totally replace the existing version, but is built on the existing version thus making the software more stable and efficient. At the same time the user knowledge and skills do not go to waste. On the other hand each version of Windows has a many new set of features, making the user knowledge obsolete. As an example a user working with Windows-Me has too educate himself on a variety of new features when he moves to Windows 2000 or Windows XP.

Simplified: Until recently Linux has been more difficult to install and use because of the terminology. But for last two years many companies have been working on this and have made Linux considerably easy to use and load.

Stability: Linux system rarely crashes; this is because the core of the operating system also called the kernel is small low level operating program. So even when things go wrong with a higher level program/application, only that program is affected but the kernel keeps working without crashing.

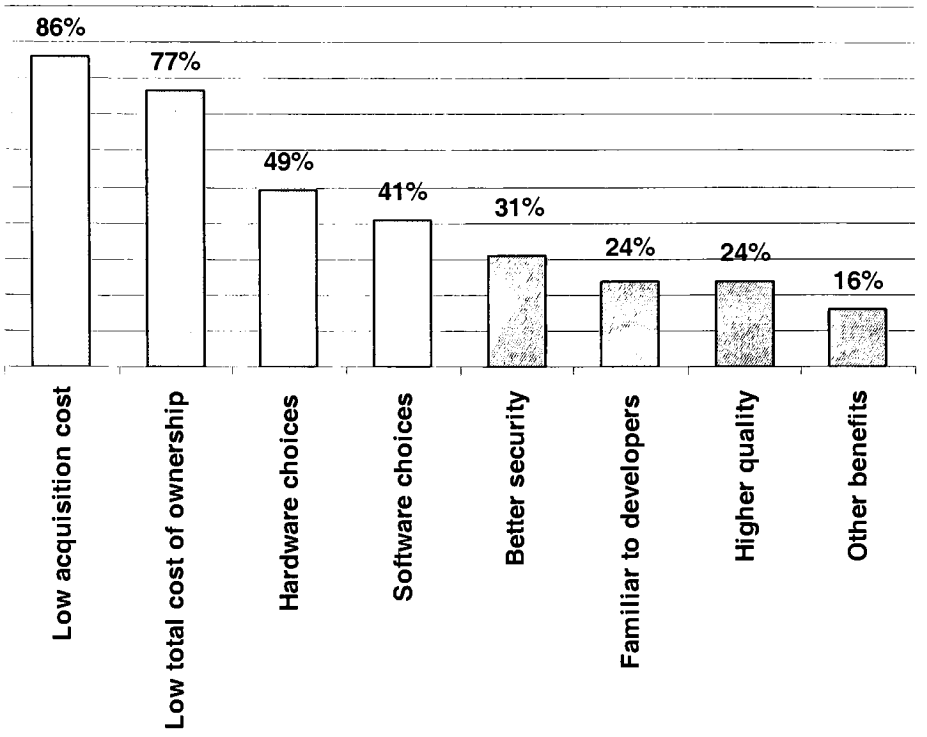
Also unlike Windows where the file system has to be defragmented regularly to prevent it from slowing down, a Linux file system does not have to be defragmented.

Linux does not have to be rebooted after installing a new program. This saves valuable user time and is less frustrating.

Last but most important Linux is inexpensive and has many free and inexpensive programs available for download.

An article published by Forrester Research, Inc. in 2004, reported in their findings when they surveyed 85 North American firms, showing that Low acquisition cost was the primary reason why these firms moved to Linux and other open source software, followed by Low Total cost of ownership and then low Hardware cost. The results of the survey are presented in the figure below

Figure 1.1 Benefits using Linux and other open source software



1.2 Background of Available Operating Systems

1.2.1 Windows 2000

Microsoft Windows has two main lines "Win9x" which consist of Windows 95, 98 and Me and "NT class" which includes of Windows NT, 2000 and XP.

Microsoft Windows 2000 was derived from the Windows NT line of operating system. The NT line in 1992 with version NT 3.1s started to show many problems mainly because of the high memory demands exceeding 16MB and overall poor performance. Their next version NT 3.5 was more efficient but had other problems. Therefore Microsoft launched "NT 4.0" in year 1999, which was a major success in the server operating system market.

The NT line version 4.0 made many computer tasks remarkably simple, and when installed and supervised with care on a good computer, it was quite stable. Windows NT 4.0 included versions for alpha, MIPS and PowerPC platforms.

In early 2000 Microsoft launched Windows 2000 which was based on NT 5.0 technology. Windows 2000 was more stable had better hardware support and was capable of running more applications. Currently Windows 2000 is the most widely deployed Operating System in the market and it is available for Intel and Intel-compatible machines.

There are three versions of Windows 2000 servers existing in the market today.

- The Windows 2000 Server
- Advance Server
- Datacenter Servers

They have varying levels of capability with Windows 2000 Advance Server supporting up to eight processors as opposed to four in Server and two in Professional. It also supports up to 8GB of memory (physical RAM) as opposed to 4GB in Server and Professional, and supports for Intel's Profusion chipset, network load balancing, rolling upgrades and clustering.

The Windows 2000 datacenter Server is the most advance server product of the 2000 family and is not available as a standalone product. It is sold in combination with specific systems that are built from ground up. Datacenter Server is typically built with fault tolerant and redundant components for stability; the systems can expand up to 32 processors and can support up to 64GB of physical Ram per server.

The difference between professional and server editions are only on architectural level. Professional can be used as a limited variety of server having some restrictions in the number of inbound NetBIOS connections.

1.2.2 Linux

Linux is the open source UNIX variant that has become popular over the last decade. Started in 1991 by Linus Benedict Torvalds a 21 year old student at the University of Helsinki Finland, Linux was one of Torvalds's school projects, to develop a UNIX-based operating system that would be provided free. Since then Linux user group has grown from a small group of aggressively devoted people to hobbyists and hackers and today several leading Information Technology (IT) vendors and corporations around the world have adopted Linux as their operating system of choice.

Linux provides all the advantages of security, scalability and performance that UNIX has over the other leading operating system (Windows) available on commodity based hardware platforms. As the original source code for Linux is free, the cost of ownership involve only the additional

options and services that the respective Linux vendors provides and is generally a magnitude less than comparable proprietary Unix operating systems. Linux is available from a number of commercial vendors who add value to the original source by enhancements to it. These vendors also provide support services to their clients to make Linux a viable and dependable product.

Earlier several Corporations and large enterprises preferred UNIX to Windows because of the stability. With Linux now becoming popular the trend is to move to Linux during the upgrades. The rationale for the move to Linux is that there are significant savings in Capital and O&M costs compared to the costly Proprietary ship of Unix servers. Linux being a variant of UNIX has essentially the same functionality. However, Linux can run on inexpensive commodity a server as opposed to the expensive proprietary severs that run UNIX. It also supports clustering, which means that several inexpensive commodity servers can be clustered together to provide the same computing power as an expensive proprietary UNIX server. Whereas the rationale for migration to Linux on the equipment side is clear, it is not so clear for the migration of software already working on UNIX servers. One of the biggest costs for Linux are the one time migration costs including training system administrators to come up to speed with Linux. Other migration costs include code that may have to be rewritten, data that must be migrated, integration work to back-end systems, and software that must be purchased to replicate a capability that already exists on the platform Linux is displacing.

Technical reviews in literature describe Linux as a cost-effective, stable, reliable, available and scaleable server platform.

Linux comes in different flavors. Flavors are the different distributions or variety. All Linux distributions released around the same time frame will use the same Kernel (the heart of the operating system) but has different additional software, GUI, installation process, price, documentation and technical support.

Other advantages: On a Workstation, Linux can be customized inside out the way user wants. The package set and the modules chosen during the installation of the operating system will describe the capabilities of the operating system and its uses. A workstation can be converted to a server and a server can be converted to a workstation by little work. It does not require reinstallation of the Operating System

Currently Linux Operating System is available through commercial vendors such as:

- The Red Hat Software Inc.

- Slackware
- The Softlanding Linux System Release (SLS)
- The TAMU (Texas A&M University) Linux Release
- H.J. Lu's bootable rootdisk
- The Manchester Computing Centre Interim Release
- Trans-Ameritech
- The Linux Support Team Erlang Distribution (LST)
- SuSe Linux
- InfoMagic Developer's Resource CD-ROM Kit

1.2.3 Red Hat Linux

Due to fact that Red Hat Linux has been in the market for long, and that the company provides extensive support services, for this research we will be only considering Red Hat Linux.

Red Hat Enterprise Linux is the leading brand of Linux in the market today. Its Advanced Server (AS) version 2.1 is the flagship operating system and enterprise Linux solution. Its salient features are listed below:

- Supports the largest Intel based architecture servers
- Available with the highest levels of support
- Industry-standard benchmark results
- Certified by US Defense Information Systems Agency as Common Operating Environment Compliant
- Features an extended release cycle for long-term stability
- Built with open source technology in collaboration with Oracle, Dell, and the open source community
- Enhanced enterprise-tuned kernel for greater computing performance, improved I/O, and efficient usage of computing resources
- Includes Red Hat Cluster Manager for high availability computing needs
- Red Hat Network Enterprise Service for simplified management of multiple systems
- Certified compatibility with top vendors including BEA, CA, Veritas, HP, IBM and Dell

Table 1.1 a list of modules that come with Red Hat Linux and their functions

Table 1.1 Modules of Red Hat Linux

Module	Function
Apache	Is an open source HTTP web server for Unix platforms (BSD, Linux and Unix Systems) and Microsoft Windows.
Samba	Is a free software implementation of Microsoft's networking system. As of version 3, samba not only provides file and print services for various Microsoft Windows clients but can also provide domain services, either as a Primary Domain Controller (PDC) or as a Backup Domain Controller. It can also be part of an Active Directory
NFS	Network File System is a protocol defined as a file system which allows a computer to access file over a network as if they were on its local disks
FTP	File Transfer Protocol is a part of the Internet protocol suite that is able to transfer computer files between machines with widely different operating systems
DHCP	Dynamic Host Configuration Protocol provides a means to allocate IP addresses dynamically to computers on a local area network
DNS	Domain Name System is a system that stores information about host names and domain names on networks, such as the Internet Most importantly, it provides an IP address for each host name, and lists the mail exchange servers accepting e-mail
GATED	A program which supports multiple routing protocols and protocol families
IMAP	Internet Message Access Protocol is an application layer internet protocol used for accessing email on a remote server from a local client
iSCSI	The iSCSI protocol uses TCP for its data transfer This enables low-cost centralization of storage without all of the usual expense and incompatibility normally associated with Fiber Channel storage area networks
PXE	Pre-boot Execution Environment PXE allows the setup of parameters and DHCP data for the purpose of retrieving the IP address and location of the bootstrap from the network
TUX	TUX is also the name of Linux kernel based web server which is able to serve static web pages much faster than traditional servers
UUCP	Unix to Unix Copy Protocol is a Protocol allowing remote execution of commands and transfer of files, emails and netnews between Unix computers not connected to Internet
AMANDA	Advanced Maryland Automatic Network Disk Archiver is a computer archiving tool that is able to backup data via a network

Inews	A UNIX program for posting Usenet news articles

Other modules include but are not limited to: ypserv, isicom, squid, routed, sliplogin, mailman, wu-ftpd, bootparamd, Cluster Manager, and piranha.

1.3 Trends

Today the existing Windows 98 users are slowly upgrading to Windows 2000 or the new Windows XP Operating System. Since the release of XP in October 2001, it has been able to capture one third of the market share while Windows 98 reached the same benchmark in six months. This is mainly because some of the users using Windows 98 are satisfied and see no benefit to upgrade to XP. Others who want to upgrade find it costly to do so.

Microsoft OS Global Web Usage Share as of May 7, 2003	
Windows XP	34.73%
Windows 98	24.93%

Another survey points out that Microsoft dominates the Operating system market today and will continue to do so till the year 2007. A report by Worldwide Client and Server Operating Environment Market Forecast and Analysis, 2002-2007 reports that Windows desktop operating system sales increased from 93.2 percent in 2001 to 93.8 percent in 2002 making the number of XP operating system shipped to 113 million. While the Linux share went up to 2.3 percent in 2002 making the number of operating system shipped to 2.9 million.

At the server end too, the operating system market is dominated by Microsoft which is reported to have had a share of 50.5 percent in 2001 and 55.1 in 2002. Linux being popular for server operating system than desktop had a market share increase to 23.1 in 2002 from 22.4 in 2001.

Support for Windows 2000 from Microsoft and third parties for hardware and software is without question the best. Windows is the most popular operating system and most of the programs that run on conventional Windows (Windows 95/98/Me) will run in Windows 2000. As of 2003 most of the hardware peripherals have Windows 2000 drivers.

On the other hand support for Linux has been weak until recently. It was believed that word perfect application will lift the Operating System off the ground but the product was never marketed right and failed to provide the

kind of awareness and promotion needed to convince the users that Linux could be an alternative operating system

The support cost comparison between the two operating system are presented in Section 3

1.4 Comparison of Windows and Linux

In the previous sections we have looked the available operating system options from Windows and the different available distributions of Linux and the trends. The below table 1.3 is a quick comparison of the two operating systems in terms of looks, reliability, file system etc.

Table 1.2 Comparisons between Windows and Linux

No.	Windows	Linux
1	**Flavors** All the flavors come from Microsoft	Flavors also called distributions or 'distros' come from different companies e.g. Red Hat, SuSe, Lindows, Lycoris
2	**Graphical Users Interface (GUI)** GUI keeps changing with each version. GUI is part of the operating system	Mainly two types of GUI's KDE and Gnome. GUI are optional in Linux
3	**Text Mode Interface** Also called command interpreter or DOS prompt. Different versions have different interpreters	Referred to as shell in the Linux world. Linux supports multiple command line interpreters such as BASH (Bourne Again Shell), Korn shell, ask and C shell
4	**Cost** For desktops and servers the operating system is expensive. An upgrade to Windows XP from an earlier version can cost between $150 and $200. Also one license key is good for one computer only	The OS cost is very cheap or free. Linux can be downloaded for free from the internet or can be purchased from a vendor for around $40 (with support and couple of free applications). Also one license is good for multiple computers
5	**Ease of use** Easy to install. Windows being the most common OS terminology is common and easy to understand Windows has to be installed on a hard disk for it to run and occupies about 2GB of hard drive space	Different versions have different installation methods. Compared to Windows, Linux is difficult to install. Terminology is not so common hence difficult. Linux on the other hand needs less

		space on hard drive because the core of the program called kernel is small and less complicated. Some versions of Linux can also run completely from a CD without installing it on the hard drive (though the speed of operation is slow). Some examples of CD versions of Linux are Knoppix, SuSe - Live Eval, Lindows, Free BSD – LiveCD.
6	**Applications** Variety of applications available for which vary in price.	Not as many applications as Windows. But the ones which are available, most of them are free.
7	**Installation of applications** The installation of applications under Windows is consistent.	Most Linux distributions come with the essentials software such as open office, Evolution and Gimp. But installing third party software varies with each version of Linux thus making adding to the complexity.
8	**Viruses & Bugs** Many viruses	Negligible viruses compared to Windows.
	Windows is known to have a number of bugs. Also in March 2003 Microsoft announced that it will not issue fixes for bugs in NT4, so that they force people to move to the next version of their OS.	Linux on the other hand is known to have fewer bugs a major reason is because there is no pressure to release the software in the market before it is fully ready. Also the bug once identified is fixed faster as there are number of people working on it to fix it and get recognition. Unlike Microsoft all bugs are taken care of in all versions of Linux.
9	**Security** A Windows system can be configured to skip user id/password at boot. Windows XP home edition has administrator type user who has total access to the system and restricted user who has limited access and cannot install software.	Linux does not allow skipping the login feature at beet. Linux does not have the detailed level of security like Windows since the security is applied to files and directories. Linux allows two types of logins root-user has full access to the

	XP professional and Windows 2000 have additional levels of security and groups of system access can be set or a user	system and normal user
10	**Software Restrictions** Windows has a variety of software and has no major software restrictions.	Linux has limited variety of software as not all manufactures make their software for Linux. There are some programs like CrossOver Office by CodeWeavers which allow Microsoft office to run on a Linux machine. Wine is another program which allows some Windows games to run on Linux machines. Ximian by Novel coming out with software which will enable Microsoft .Net applications to run on Linux machines. There are also products like VMware virtual machines which allow Windows operating system to run on a Linux machine.
11	**Networking** Since they both can communicate using TCP/IP, Windows machines can work fine on Linux network	Similarly Linux machines work fine on Windows network
12	**Hardware devices support** The hardware support for Windows operating system is undoubtedly much superior as compared to Linux. Most of the manufacturing companies have drivers for most of the current versions of Windows	With Linux, hardware support is a big drawback. Not all manufacturers make drivers for Linux, not to mention different Linux versions might require different drivers
13	**CPU's** The range of hardware platforms is limited. Also due to the increasing complexity of the program with each release calls for stronger machines.	Linux can run on variety of hardware platforms. Linux like Windows does not require very strong machines for the same processing. It can run on old pc such as 486 based machines. This is a major advantage as users do not have to upgrade their hardware with each release of the operation resulting in substantial savings.

14	**Multiple Users**	
	Windows out of the box does not allow multiple concurrent users. At one time only one user can log on, though many users can access a database running on Windows. There are some programs like terminal service which allow multiple concurrent users.	Linux allows multiple concurrent users to log on at the same time.
15	**File Systems**	
	The most common and stable file system is NTFS, though older versions are FAT12, Fat16 and FAT32	The most common file system today is ext3 though the older versions had ext2. ext3 like NTFS are journaled file system which allows automatic recovery when the system crashes or is stopped all of a sudden.
16	**File Hierarchy**	
	Volume based file hierarchy – letter of alphabets are used to name different devices e.g. C: D:	Unified scheme file hierarchy – all the devices are attached to the root also denoted by a forward slash "/" e.g floppy disk will be denoted as /etc/floppy
17	**Hidden Files**	
	Hidden file feature is a file attribute in the file metadata	Hidden file names have a period before their name
18	**Case Sensitive**	
	File names are not case sensitive	File name are case sensitive e.g. "dir" is not the same as "Dir"

1.5 What People think?

Below is section summarizing various articles from different resources on the two operating systems and what people think, what is the current trend and what is the future of the two operating systems. The Link presented below each paragraph is the link to the main article.

1. In October 2002, Computer World magazine quoted the chief technology architect at Merrill Lynch & Co. in New York as saying that "the cost of running Linux is typically a tenth of the cost of Unix and Microsoft alternatives." The head technician at oil company Amerada Hess manages 400 Linux servers by himself. He was quoted as saying "It takes fewer people to manage the Linux machines than Windows machines."

   http://www.businessweek.com/magazine/content/03_09/b3822610_tc102.htm

2. An interesting article on Langa.com talks about the complications in Linux and advices the users who plan to migrate from Windows to Linux to be prepared to accept the new rules of engagement as it is a new environment. And that the hardware compatibility cannot be assumed as with Windows. The writer further comments that this new environment and challenge could be a show stopper for some people which I believe is very true.

   http://www.langa.com/newsletters/2004/2004-05-20.htm

3. IBM's upcoming family of "Blue Gene" supercomputers, which will be used by Lawrence Livermore National Laboratory for nuclear weapons simulations, will run Linux.

   Sony and Matsushita (parent company of Panasonic) will use Linux to build increasingly 'smart' microwave ovens, TVs and other consumer gizmos. Likewise MontaVista Software will release a version of its embedded Linux for use in consumer electronics devices. NEC is working on Linux-based cell phones and Motorola is going to make Linux its primary operating system for smart phones.

   http://www.winnetmag.com/Article/ArticleID/40481/40481.html

4. Linux generally needs less hardware horsepower than Windows. Papa John's converted 2,900 pizzerias to Linux to get more mileage out of its old hardware.

Talking about percent of market share of Microsoft v/s share of Linux Staf Verhaegen and Rob point out that many a times the servers and the desktops are shipped with Windows operating system as a default and probably the only choice and are reinstalled with Linux. Thus the linux share should go up.

http://www.winnetmag.com/Article/ArticleID/40481/40481.html

5. On the same note Lan Kovalsky has an interesting view, since Linux can be installed on multiple operating systems just with one copy compared to Windows which is sold by one license /CD per machine. The 23 percent of market share of Linux should be higher as they are not individual shipments.

   http://www.winnetmag.com/Article/ArticleID/40481/40481.html

6. Dave who deploys Windows and Linux servers in an enterprise points out that in his company they install free downloadable versions of Linux and then buy support from Red hat Linux. They do not show up in the customer listing of Linux owners but have many machines running Linux. Also he writes that in 2001 they were deploying 50 percent Linux and 50 percent Windows on their servers but in now they deploy 70 percent Linux and 30 percent Windows as the Linux support is more efficient and they can get their servers fixed in less downtime.

   http://www.winnetmag.com/Article/ArticleID/40481/40481.html

7. SM and Win guy in their discussion support Linux servers and refer to Windows servers as a low end desktop trying to work as a server. They feel Windows server is unstable, unreliable and has poor security. Because of all these reasons it takes more people to manage a Windows server network as compared to a Linux server network

   http://www.desktoplinux.com/cgi-bin/board/UltraBoard.pl?Action=ShowPost&Board=linvwin&Post=272&Idle=0&Sort=0&Order=Descend&Page=0&Session=

8. Another user describes his experience moving to Linux as a blessing saying that ever since he has moved to Linux in 2002 he is more productive, he can do more things and that it is simpler to use than Windows.

   http://www.desktoplinux.com/cgi-bin/board/UltraBoard.pl?Action=ShowPost&Board=linvwin&Post=250&Idle=0&Sort=0&Order=Descend&Page=0&Session=

9. Rick Waugh a technology architect at Telus in Burnaby, British Columbia expresses his vies on upgrade to the latest versions of Windows as a waste because the cost is very high to upgrade and the value it brings is low.

   http://www.pcworld.com/news/article/0,aid,104954,00.asp

10. Daniel Lyons in his article in Forbes talks about the write the applications high cost of Maintenance packages of Linux server editions ($799 to $2499) makes Linux less desirable. Also the cost of rewriting the software, training the IT staff and buying software like applications servers, web servers and directories which come free with Microsoft can make Linux an expensive solution. Microsoft was more afraid of Linux few years ago when the system was truly free. Today when the software is being sold by big vendors like IBM and Novel for a high maintenance price Microsoft is more confident.

    Also in the article Richard Steel points out the Linux lacks the ability of running on tablet PCs

    http://www.forbes.com/technology/enterprisetech/2004/08/31/cz_dl_0831msft.html

11. A recent article I PC magazine talks about the speed and scalability of Linux and Samba

    "Results published this week in IT Week's sister publication PC Magazine show that the latest Samba software now surpasses the performance of Windows 2000 by about 100 percent under benchmark tests.

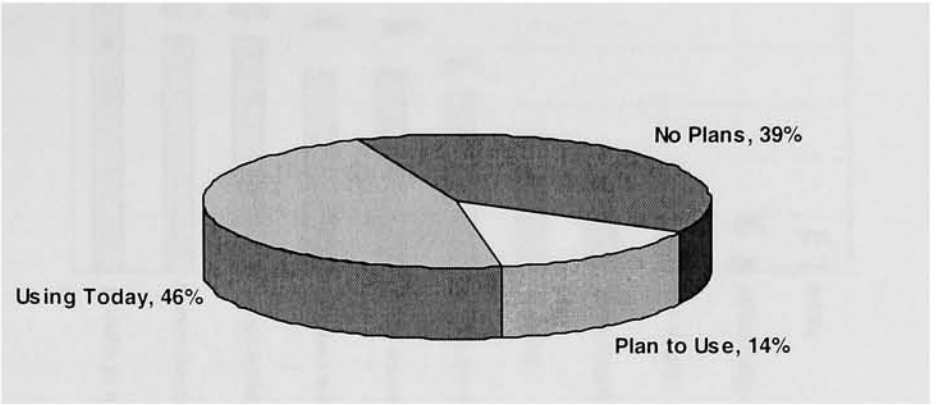
    "In terms of scalability, the results show that Linux and Samba can handle four times as many client systems as Windows 2000 before performance begins to drop off. Consequently firms can save money on hardware and software upgrades, and can avoid the administrative and financial costs of licensing Windows file servers, by using the Samba alternative ..."

    http://www.linuxtek.com/whylinux/

12. A recent survey by Forrester Research, Inc. of 140 companies in North America on their views of Linux and open source software concluded that many companies are using Linux or open source software and the number is increasing considerably every year. Of the 140 companies surveyed the results to the basic question of

using or planning to use Linux within a year are presented in Figure 1.2

Figure 1.2 Companies using or planning to use Linux within a year

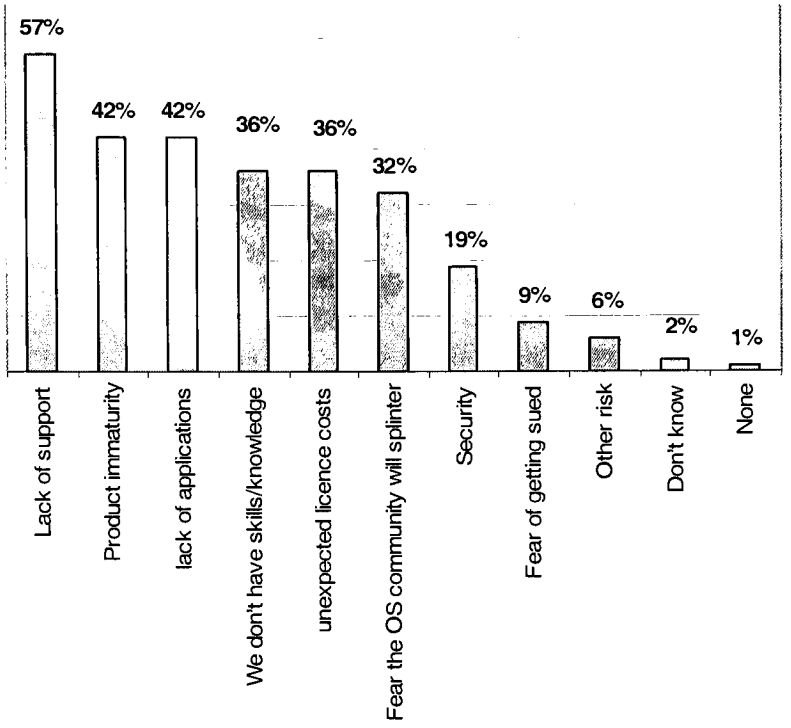


1.6 Why are People concerned about Linux?

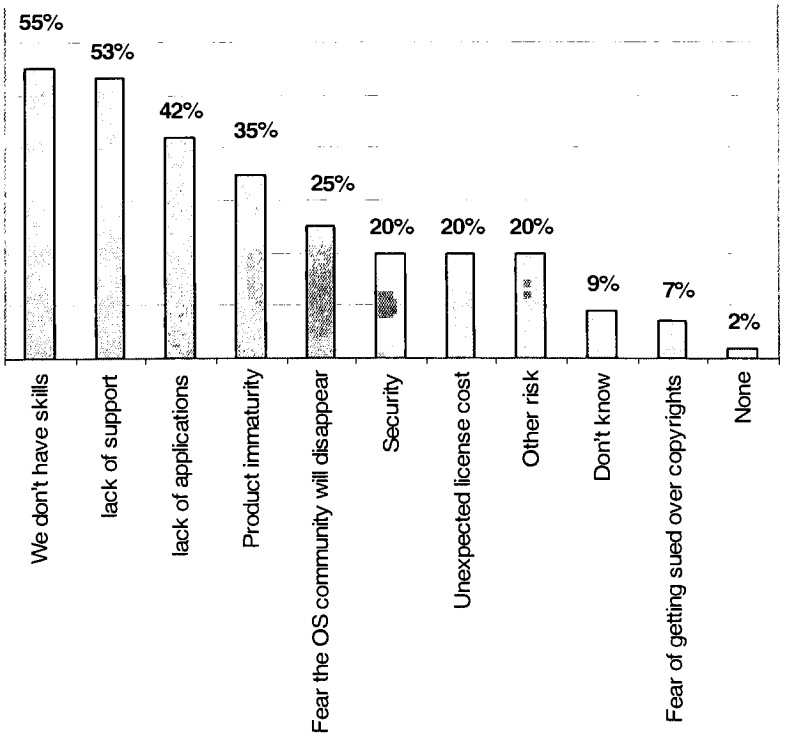
Open source technologies have a great deal of risk, and one the main reasons that commercial software companies exist is to shift the risk from upgrades, maintenance and support away from in house IT staff. The open source movement shifts all of those problems to the customer. There is so much concern right now associated the risks of open source that it can be very difficult for a customer or a user to understand and know what is real or what is just marketing strategies.

Figures 1.3 and 1.4 present a summary of survey data completed by Forrester Research Inc., to access an understanding of the biggest concerns of companies using or planning to use Linux or other open source software.

Figures 1.3 Concerns of firms using Linux and or open source software



Figures 1.4 Concerns of firms not using Linux or open source software



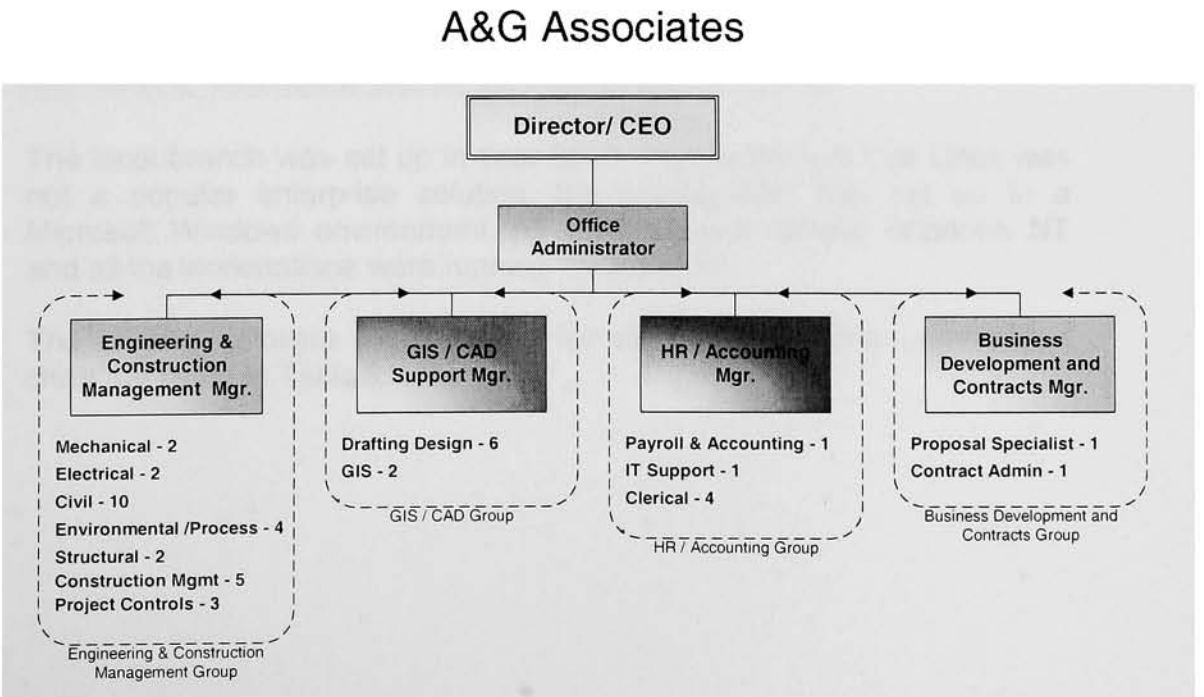
Case Study

2.1 Defining the Case Study

In order to evaluate the opportunity of transitioning from Windows Operating System to a Linux Operating System we will utilize an existing branch from an international firm working mainly in Central America. A&G Associates was established by setting up a local network which included 4 servers and 50 Workstations. This firm specializes in the design and construction management of water and wastewater treatment facilities. In order to accomplish the work this firm is organized in accordance with the organization chart presented in Figure 2.1.

The firm can be divided into four main functional departments; the first department is engineering and construction management which focuses into design and construction management services. Within this division reside different engineering specialties including Mechanical Engineering, Electrical Engineering, Civil Engineering, Environmental & Process Engineering, Structural Engineering, Construction Management and Project Controls. The number of specialist working in each discipline is listed next to each discipline title.

Figure 2.1 Organization Chart



The second group is the GIS/CAD support group; this group is in charge of preparation of graphics for the marketing department during proposals preparation, as well as preparation of engineering drawings and support documents for environmental documents and regulatory permits.

The third group is Human Resources/ Accounting, which includes the staff skilled in Human Resources, Payroll and Accounting, IT Support and Clerical

The last group is the Business development division which includes staff specialized in Marketing/Proposal Preparation and Contracts Management and Administration.

Due to the size of this branch the staff within all the division is cross trained in such a way that they can perform activities in the different fields. For example the human resources and accounting manager will support the contracts admin side as well as the payroll and accounting, and is a specialist in managing the company staff. Similarly the engineering and construction manager can perform work in different divisions like environmental processes and civil engineering. The engineering construction division includes senior staff as well as Associate and Junior engineers in the ratio of approximately 20 percent Senior, 50 percent Associate and 30 percent junior engineers. This distribution was selected in order to be able to train junior staff rapidly allowing them to transition them to higher positions in the firm and also to prepare them for the training of new junior staff acquired.

2.2 Software Needs and Requirements

The local branch was set up in year 2000. Due to the fact that Linux was not a popular enterprise solution, the organization was set up in a Microsoft Windows environment. All servers were running Windows NT and all the workstations were running Windows 98.

The original software requirements for each group in the organization chart are listed in Table 2.1

Table 2.1 Software Requirements for A&G Associates

Software Name	Group 1	Group 2	Group 3	Group 4
Internet explorer	☑	☑	☑	☑
Outlook	☑	☑	☑	☑
Address Book	☑	☑	☑	☑
Word	☑	☑	☑	☑
Excel	☑	☑	☑	☑
PowerPoint	☑	☑	☑	☑
Acrobat Reader	☑	☑	☑	☑
Acrobat Writer	☑	☑		
Photoshop		☑		
Illustrator		☑		
Microsoft Project	☑			
Visio		☑		
WinZip	☑	☑	☑	☑
ArcInfo/ ArcView		☑		
Quick Books Pro			☑	
HydroCAD	☑			
Haestad Methods	☑			
InRoads	☑			
Pipe2000	☑			
AutoCAD		☑		
RoadEng	☑			
Access	☑		☑	
Windows 98	☑	☑	☑	☑
Windows NT	N/A	N/A	N/A	N/A
Microsoft Internet Information Server	N/A	N/A	N/A	N/A
SQL server	N/A	N/A	N/A	N/A
Exchange	N/A	N/A	N/A	N/A
Norton Antivirus	☑	☑	☑	☑
LUSAS	☑			

2.3 Software capabilities

In the previous section we identified the software requirement for each group. Table 2.2 presents software capabilities of all the software listed above.

Table 2.2 Software Requirements for A&G Associates

Software Name	Manufacturer	Capabilities
Internet explorer	Microsoft	Internet Browser
Outlook	Microsoft	Email application. Also used for calendar and contact management
Word	Microsoft	Word processing -Typing papers, letters, memos, reports
Excel	Microsoft	Spreadsheet
PowerPoint	Microsoft	Presentation tool
Acrobat Reader	Adobe	to view PDF (portable document format files)
Acrobat Writer	Adobe	to create PDF
Photoshop	Adobe	Bitmap graphic editor
Illustrator	Adobe	Vector based drawing program
Microsoft Project	Microsoft	Project Management tool. Used for scheduling, resource analysis and cash flow
Visio	Microsoft	Diagramming software for drawing charts, network diagrams, models and data diagrams
WinZip	WinZip Computing	Compression utility to compress large files
ArcInfo / ArcView	ESRI	Produce geoprocessing models for discovering relationships, integrating data and statistical analysis
Quick Books Professional	Intuit	Track employee time and expenses, Produce Invoices. Manage firm's financial accounts
HydroCAD	HydroCAD Software Solutions	Modeling storm water runoff and designing storm water management systems
CivilStorm	Haestad Methods	Dynamic storm water analysis

InRoads	Bentley	Road design, corridor design, road widening, road resurfacing, landfill design, and building site design
Pipe2000	KY Pipe	Pipe system hydraulic flow analysis
AutoCAD	Autodesk	Computer assisted design software for 2D and 3D designing and drafting
RoadEng	Softree	surveying, mapping, civil design and road engineering
Access	Microsoft	Database management system
Windows 98	Microsoft	Operating system for workstations
Windows NT	Microsoft	Operating system for servers
Microsoft Internet Information Server	Microsoft	Web server
SQL server	Microsoft	Database management system
Exchange	Microsoft	Messaging and collaboration server
Norton Antivirus	Norton	Identify and eliminate computer viruses
LUSAS	Finite Element Analysis Ltd	Solve linear static and dynamic structural and thermal analysis problems

2.4 Software equivalency (Windows to Linux)

If A&G decides to transition to a Linux Operating System, table 2.3 presents a cross-reference between Windows & Linux Programs

Table 2.3 Cross-reference between Windows & Linux Programs

Windows Software	Linux Equivalent
Internet explorer	Netscape / Mozilla.
Outlook	Evolution
Word	Star office
Excel	Star office
PowerPoint	Star office
Acrobat Reader	Acrobat Reader
Acrobat Writer	Adobe Acrobat Distiller
Photoshop	Gimp
Illustrator	Corel Draw 9
Microsoft Project	MrProject
Visio	Dia
WinZip	Gnozip
ArcInfo / ArcView	Quantum GIS
Quick Books Professional	Quickbooks
HydroCAD	N/A
CivilStorm	N/A
InRoads	N/A
Pipe2000	N/A
AutoCAD	LinuxCAD
RoadEng	N/A
Access	InterBase7
Windows 98	Redhat Linux 8.0
Windows NT	Redhat Linux 8.0
Microsoft Internet Information Server	Apache
Proxy Server	Squid
SQL server	Postgre SQL
Exchange	Netmail
Norton Antivirus	Trend ServerProtect
LUSAS	FEIt

A complete list of software and their cross reference is listed in Appendix A.

2.5 Software Challenge

Since the firm was established in early 2000 using Windows 98 environment for workstations and Windows NT for servers. At this time the firm is facing the challenge to upgrade their system in the Windows environment which entails choosing Windows XP for workstations and Windows Advance Server 2000 for servers or Transitioning to a different operating System such as Linux. The following sections will analyze the upgrading of the existing system to Windows environment and the opportunity to transition to Linux considering factors such as cost involved to acquire new hardware and software, system operating cost, and staff training cost.

Cost of Transition

3.1 Introduction

The most important reason to move to Linux will come from a price comparison between the Windows and Linux Operating System. Since Linux can be downloaded for free or a licensed CD can be bought for less than $200 dollars and can be used on multiple computers, and many applications for Linux are free, it seems to be the best cost effective solution. This section will focus on the economics of upgrading the operating system for the practical case presented in section 2. For this practical case, it is difficult to quantitatively analyze all the factors contributing to the total cost of ownership (TCO), including stability, reliability, and downtime during the transition. Therefore, this paper will only take into account the cost associated with hardware, software and operations.

Other factors such as IT staff skills, ease of deployment, application availability, risks associated and performance considerations would be minimized if the transition is conducted by a hired outside consultant, specialized in this field. Also, due to the fact that the firms has only one IT specialist, it is best for the migration to Linux or new Windows system to be outsourced to an consulting company to ensure that the migration is efficient and with minimum downtime.

Further it is assumed that Windows and Linux will use the same network components such as a wiring, switches, routers, power supply (UPS), so the cost for these components will be same for both solutions and will not be considered in this evaluation.

Also, understanding that the applications on Windows involved a cost for acquisition and that many applications on Linux are for free, however the cost involved is not substantial to be considered in the analysis for the transition in this case study.

The analysis is based on two alternatives, including:

1. **Full transitioning** - upgrading all servers and workstations to a new operating system

2. **Partial transitioning** - which entails the transition of some computers to Linux and some computers to Windows forming a hybrid environment

Since the existing hardware is 4 years old it is recommended that we change the hardware to the latest technology so that the new operating systems Windows or Linux can run more efficiently.

Table 3.1 lists the Hardware Cost for this case study, including 4 servers and 50 staff workstations.

Table 3.1 New Hardware Cost

Hardware Cost

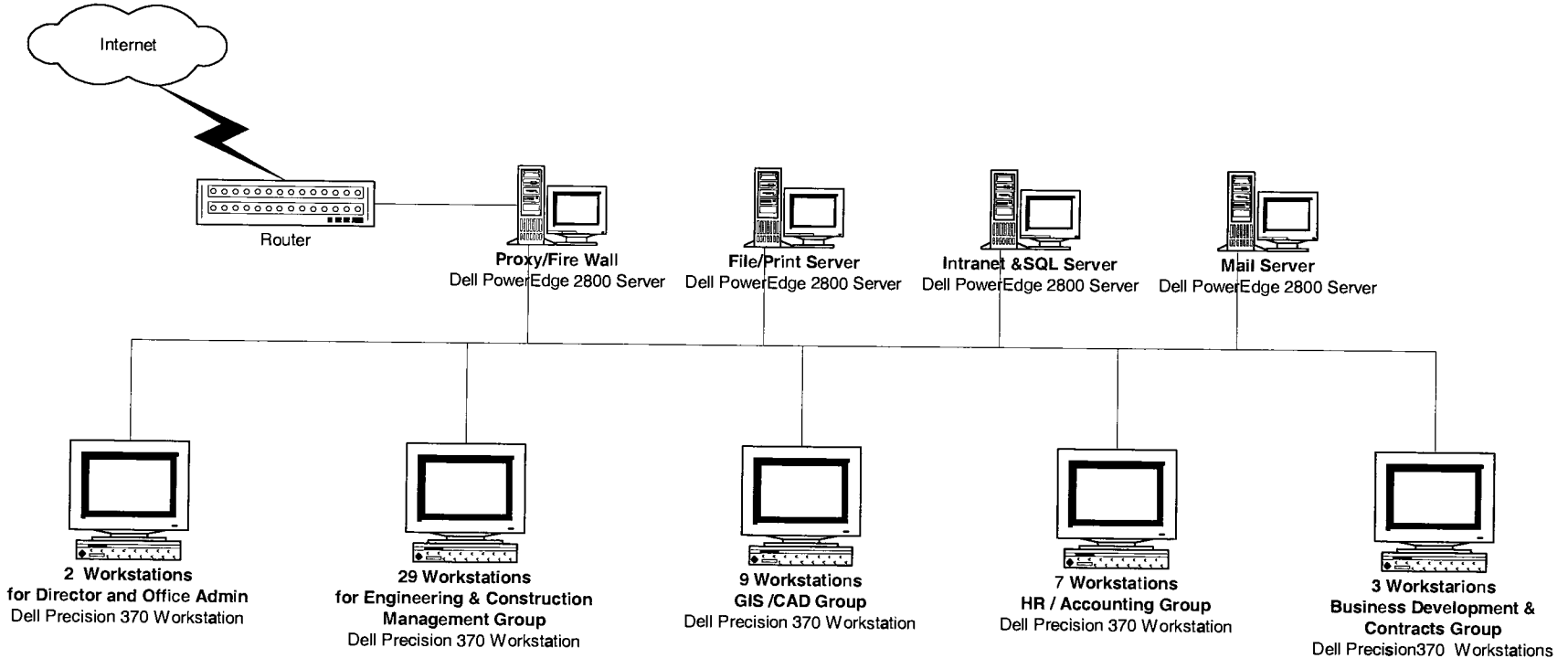
Type	Specifications (1)	Price/Unit	Units	Total Cost
Mail Server	Dell PowerEdge 2800 Processor: Intel® Xeon™ processor at 3.0GHz/1MB Cache Memory : 4GB DDR2 400MHz (2X2GB), Dual Ranked DIMMs Storage: 146GB 10K RPM Ultra 320 SCSI Hard Drive Monitor: Dell E773 Monitor, 17 inch (16.0 Inch Viewable), Gray	$4,453	1	$4,453
Proxy / Firewall Server	Dell PowerEdge 2800 Processor: Intel® Xeon™ processor at 3.0GHz/1MB Cache Memory : 4GB DDR2 400MHz (2X2GB), Dual Ranked DIMMs Storage: 146GB 10K RPM Ultra 320 SCSI Hard Drive Monitor: Dell E773 Monitor, 17 inch (16.0 Inch Viewable), Gray	$4,453	1	$4,453
File / Print Server	Dell PowerEdge 2800 Processor: Intel® Xeon™ processor at 3.0GHz/1MB Cache Memory : 4GB DDR2 400MHz (2X2GB), Dual Ranked DIMMs Storage: 146GB 10K RPM Ultra 320 SCSI Hard Drive Monitor: Dell E773 Monitor, 17 inch (16.0 Inch Viewable), Gray	$4,453	1	$4,453
Intranet and SQL Server	Dell PowerEdge 2800 Processor: Intel® Xeon™ processor at 3.0GHz/1MB Cache Memory : 4GB DDR2 400MHz (2X2GB), Dual Ranked DIMMs Storage: 146GB 10K RPM Ultra 320 SCSI Hard Drive Monitor: Dell E773 Monitor, 17 inch (16.0 Inch Viewable), Gray	$4,453	1	$4,453

Workstations	Dell Precision Workstation 370 Intel® Pentium® 4 Processor 2.80GHz, 1MB/800, Microsoft® Windows® XP Professional, SP2 with Media	$1,600	50	$80,000
			Total	$97,812

(1) The main reason for the selection of the same type servers as specified in this table is to maintain uniformity in hardware and for easy of maintenance. To see a full specification for the servers see Appendix B and for the workstations see Appendix C.

Figure 3.1 presents the updated network diagram for A&G.

Figure 3.1 Basic Network Diagram for A&G Associates



3.2 Economics Full Transitioning

In order to analyze the full transitioning we need to evaluate two options

4. Transition from the existing Windows 98 environment into the newest version of Windows XP for workstations and servers from Windows NT to Windows 2000 Server.

5. The second option will evaluate the transitioning from an existing Windows 98 environment to a Linux environment for workstations and servers.

3.2.1 Full Transition 1: Windows 98/NT to Windows XP/2000

This transition will entail moving all workstations running Windows 98 to Windows XP and all servers running NT to Windows Advance Server. To do this transition it will require upgrading of all existing servers and workstations to more powerful systems as listed in table 3.1

The total cost for the transition in this case will include the cost of the software, hardware and operations. The tables below will present the cost associated in each case.

The Cost of Operating System, back- office technologies and productivity tools for Windows environment are listed in table 3.2

Table 3.2 Software Cost Windows – Environment

Software Cost - Windows Environment

Type	Price/Unit	Units	Total Cost	Comments
Microsoft Advance Server	$3,999	4	$15,996	Includes 25 Clients Access licenses (CALs). Additional CALs are $67 each
Microsoft Internet Information Server (Web Server)	$0	2	$0	Comes free with Microsoft 2000 Server
Microsoft ISA Standard Server 2004	$14,999	1	$14,999	This is a per processor license. Product includes firewall and virtual private network and Web cache solution.
Microsoft SQL Server	$3,999	1	$3,999	This is a per processor license.
Microsoft Exchange Server 2003	$3,999	1	$3,999	A CAL is required for each user. CAL's are $67 each
Windows XP Professional Edition	$299	50	$14,950	This is a per user license
Microsoft Office Professional	$479	50	$23,950	This is a per user license
Internet Explorer	Free			Comes free with Windows XP and 2000 Server
Additional Client Access Licenses	$67	29	$1,943	For Exchange and Advance Server
	Total		$79,836	

Table 3.3 presents the yearly cost associated with the operations of the system, mainly for professional support. The yearly cost associated with IT staff is the same in all cases and since the transition of the system is done by an outside consultant, these costs are not considered in this category.

Table 3.3 Operating Cost - Windows Environment

Operating Cost - Windows Environment

Windows 2000 Advance Server Microsoft Support			
Type	**One Year**	**Three Years**	**Comments**
Online	$99	$297	per incident
Phone	$245	$735	per incident
	$1,225	$3,675	for five incidents/year
Remote Advisory	$210	$630	per hour consulting fee
Onsite Training for Employees and IT Staff	$8,000	$8,000	80 hours at 100 per/hr
Total	$9,779	$11,675	

The total cost associated with a full transition 1 is summarized in Table 3.4.

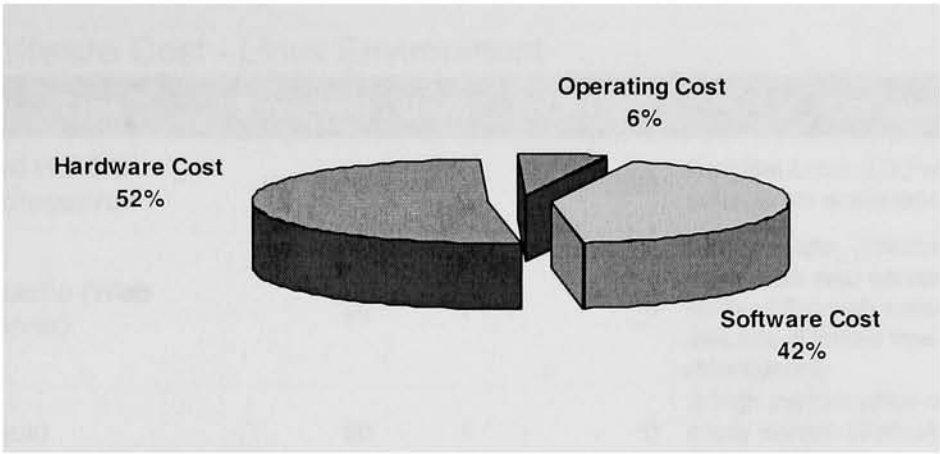
Table 3.4 Total Cost for Full Transition 1

Total Cost - Windows Environment

Category	Price
Software Cost	$79,836
Hardware Cost	$97,812
Operating Cost (3 years)	$11,675
Total	$189,323

Figure 3.2 shows the ratio of software cost, to hardware cost and operating cost for a full transition to Windows

Figure 3.2 Total Cost - Windows Environment



3.2.2 Full Transition 2: Windows 98/NT to Linux

This transition will entail moving the existing workstations running Windows 98 and the existing servers running Windows NT to Red Hat Linux 8.0. Similar to full transition to Windows this transition will also require upgrading of all existing servers and workstations to more powerful systems as listed in table 3.1

The total cost for the transition in this case will include the cost of the software, hardware and operations. The tables below will present the cost associated in each case.

The Cost of Operating system, back- office technologies and productivity tools for Linux environment are listed in table 3.5

Table 3.5 Software Cost – Linux Environment

Software Cost - Linux Environment

Type	Price/Unit	Units	Total Cost	Comments
Red Hat 8.0 Professional	$150	1	150	Red Hat Linux 8.0 Professional is suitable for workstations or servers.
Apache (Web Server)	$0	1	0	Most popular, efficient and extensible web server used on over 60 % of the web servers on the internet. (Comes free with the distribution)
Squid	$0	1	0	A high performance web-cache proxy server. (Comes free with the distribution)
PostgreSQL (database)	$0	1	0	Postgre SQL is a robust, next-generation, Object relational DBMS. (Comes free with the distribution)
Iptables (Firewall)	$0	1	0	Powerful Linux packet filters control utility that acts as a firewall within the Netileter framework. (Comes free with the distribution)
Sendmail or Postfix (Mail server)	$0	1	0	Send mail and postfix are fast secure mail servers. Sendmail is very popular and is used on over 80 % of internet mail servers. (Comes free with the distribution or can be downloaded from the internet)
GIMP (Graphics)	$0	1	0	A GNU image manipulation program, for photo retouching (Comes free with the distribution or can be downloaded from the internet)
StarOffice (Productivity Suite)	$0	1	0	A full featured, Microsoft Office compatible productivity suite. (Comes free with the distribution or can be downloaded from the internet)
	Total		150	

Table 3.6 lists the yearly cost for support from Red hat Linux for 50 workstations. Also, since Linux is a new environment, users will require additional training to use the operating system and the new applications. Assuming two training batches of 25 people for a week each, the cost associated with training is summarized in the same table.

Table 3.6 Operating Cost - Linux Environment

Operating Cost - Linux Environment

Desktop Red hat Linux Management Module Extension Pack			
	One Year	Three Years	Comments
24/7 phone support			
24/7 Web support			
One Hour phone support	$3,500	$10,500	per year
One business day Web support			
Onsite Training for Employees and IT Staff	$8,000	$8,000	80 hours at 100/hr
Total	$11,500	$18,500	

The total cost associated with a full transition 2 is summarized in Table 3.7

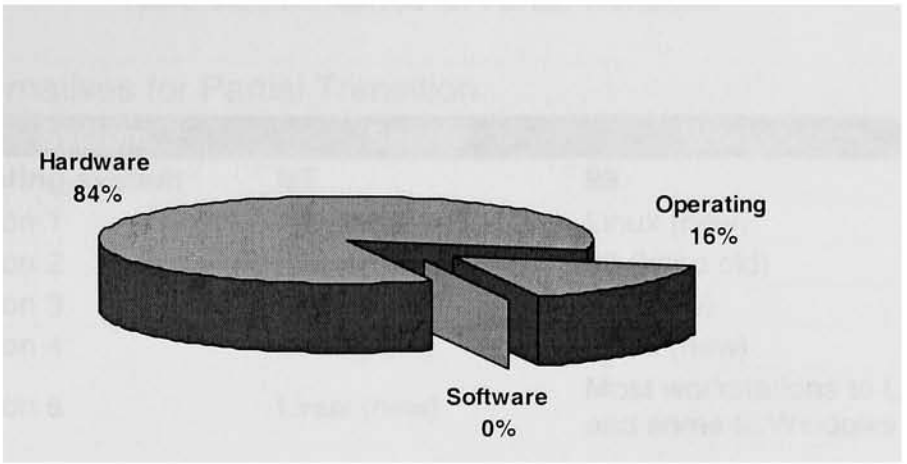
Table 3.7 Total Cost for Full Transition 2

Total Cost - Linux Environment

Category	Price
Software	$150
Hardware	$97,812
Operating (3 years)	$18,500
Total	$116,462

Figure 3.3 shows the ratio of software cost, to hardware cost and operating cost for a full transition to Linux

Figure 3.3 Total Cost - Linux Environment



A very import factor to consider under the full transitioning to Linux is the fact that A&G will require some workstation to run under the Windows Platform to perform some of the engineering modeling for which the software is not compatible with Linux at this time. Examples of this situation are Water Network Distribution Analysis or Sewer Collection modeling.

3.3 Economics of partial transitioning

The fact that it has been 4 years when the last version of operating system was installed at A&G Associates, therefore there is an urgent need of updating the existing operating system with a new version of Windows or transitioning to Linux.

The above two alternatives entailed migrating from existing Windows platform for A&G associates to the new Windows platform for servers and workstations or Linux for servers and workstations.

In this section we will summarize the cost associated with a partial transitioning of the existing system. This partial transitioning is attractive from the perspective of potential savings for A&G Associates. This partial transitioning can be accomplished by different options as listed in Table 3.8.

Table 3.8 Alternatives for Partial Transition

Alternatives for Partial Transition

System	Server	Workstation
Existing system	**NT**	**98**
Option 1	NT (keep old)	Linux (new)
Option 2	Linux (new)	98 (keep old)
Option 3	Linux (new)	XP (new)
Option 4	2000 (new)	Linux (new)
Option 5	Linux (new)	Most workstations to Linux and some to Windows XP

Partial Transitioning Options 1 and 2 are not attractive because the end result will not provide the efficiency of an upgraded system. Option 3 is possible. However Option 3 is not a good combination because we are changing 4 servers to a Linux and 50 workstations to Windows XP, the high cost of Windows on the majority of the machines will not generate savings that are attractive to A&G Associates. Option 4 is also possible, however there is a know fact that Linux is favorite for servers, and if we maintain the servers with Windows 2000 it will require the acquisition of Network CALS, resulting in an increased overall cost and less attractive option to A&G Associates.

The nature of the business of A&G is such that it requires some work stations to be left under the Windows environment in order to have the capability to run some engineering applications such as: Water Network Analysis or Sewer Collection Modeling which are not compatible with Linux at this time. This requirement will make option 4 not suitable at this time.

Option 5, is the only possible alternative for A&G, because it takes care of the issue of running engineering application on some Windows workstations and changing the majority of the workstations and all servers to Linux in order to obtain the maximum cost benefit. In this option 15 workstations are upgraded to new Windows XP Platform and all 4 servers and remaining 35 workstations are migrated to a Linux Platform.

Option 5 is identified as a hybrid system, and the software cost for this option will include cost of Linux Operating system, back- office technologies and productivity tools for 4 servers and 35 workstations and cost of Windows XP Professional and Office XP professional for 15 workstations. Since this system will use Linux network, it is not required to buy Microsoft Client Access Licenses (CAL's). The total software cost for such a setup is listed in table 3.9

Table 3.9 Software Cost – Hybrid Environment

Software Cost - Hybrid Environment

Type	Price/Unit	Units	Total Cost	Comments
Red Hat 8.0 Professional	$150	1	$150	Red Hat Linux 8.0 Professional is suitable for workstations or servers.
Apache (Web Server)	$0	1	$0	Most popular, efficient and extensible web server used on over 60 % of the web servers on the internet. (Comes free with the distribution)
Squid	$0	1	$0	A high performance web-cache proxy server. (Comes free with the distribution)
PostgreSQL (database)	$0	1	$0	Postgre SQL is a robust, next-generation, Object relational DBMS. (Comes free with the distribution)
Iptables (Firewall)	$0	1	$0	Powerful Linux packet filters control utility that acts as a firewall within the Netileter framework. (Comes free with the distribution)
Sendmail or Postfix (Mail server)	$0	1	$0	Send mail and postfix are fast secure mail servers. Sendmail is very popular and is used on over 80 % of internet mail servers. (Comes free with the distribution or can be downloaded from the internet)
GIMP (Graphics)	$0	1	$0	A GNU image manipulation program, for photo retouching (Comes free with the distribution or can be downloaded from the internet)
StarOffice (Productivity Suite)	$0	1	$0	A full featured, Microsoft Office compatible productivity suite. (Comes free with the distribution or can be downloaded from the internet)

Windows XP Professional Edition	$299	15	$4,485	This is a per user license
Microsoft Office Professional	$479	15	$7,185	This is a per user license
Internet Explorer	Free			Comes free with Windows XP and 2000 Server
	Total		$11,820	

Table 3.10 lists the yearly cost for support from Red hat Linux for 35 machines. The other 15 Windows workstations will be maintained by the IT staff. These 15 workstations are not critical in comparison to a server, therefore, if and when required the support can be bought on a per incident basis. However, for this study we will set a budget to cover this type of incidents. Additionally, training of the remaining 15 users of the Windows Environment in the use of Linux will be included, because in a small firm such as A&G the cross training of staff becomes an asset to the firm and it will more efficient to train all staff during the transitioning period.

Table 3.10 Operating Cost - Hybrid Environment

Operating Cost - Hybrid Environment

Desktop Red hat Linux Management Module Extension Pack and Microsoft Phone Support			
	One Year	Three Years	Comments
Red hat 24/7 phone support			
Red hat 24/7 Web support			
Red hat One Hour phone support	$3,500.00	$10,500.00	per year
Red hat One business day Web support			
Microsoft Phone Support	$1,225	$3,675	for five incidents/year
Onsite Training for Employees and IT Staff	$8,000	$8,000	80 hours at 100 per
Total	$12,725	$22,175	

The total cost associated with a full transition is summarized in Table 3.11

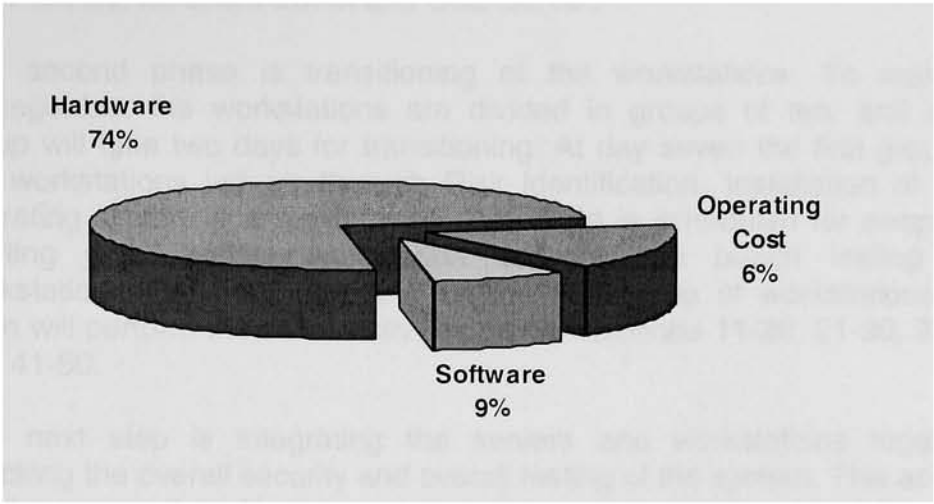
Table 3.11 Total Cost for Partial Transition Alternative 5

Total Cost - Hybrid Environment

Category	Price
Software	$11,820
Hardware	$97,812
Operating (3 years)	$22,175
Total	$131,807

Figure 3.4 shows the ratio of software cost, to hardware cost and operating cost for a Partial Transition to Linux

Figure 3.4 Total Cost - Hybrid Environment



3.4 Timeline for transition

Figure 3.5 presents the timeline required to implement the transition for the Operating System for A&G Associates. This schedule includes the major activities and their duration transition to Windows, Linux or to a Hybrid environment.

The schedule to migrate is broken into four parts: Project Development, Implementation, Documentation and Rollout/Training. The next paragraphs include a description of each one of these parts.

Project Development: This part includes forming a team of four employees from A&G Associates, who will be responsible for the implementation of the project, the decision makers and contact point for the progress of this project. This team will hire an outside consultant specializing in the migration of operating system to implement the transition for the firm. The consultant will complete the needs analysis and based on that purchase the software and hardware required.

Implementation: This part is subdivided into three phases: server Implementation, workstation implementation and Integration. Server implementation is further broken down into two groups in order to be manageable. The first group consists of Mail Server and Proxy Sever. The schedule allows for the one day to complete a risk identification for the two servers. The second day will entail installing the new operating system and other applications. Day three is scheduled for swapping the existing data from old servers, setting the security and bench testing, and fine tuning the servers.

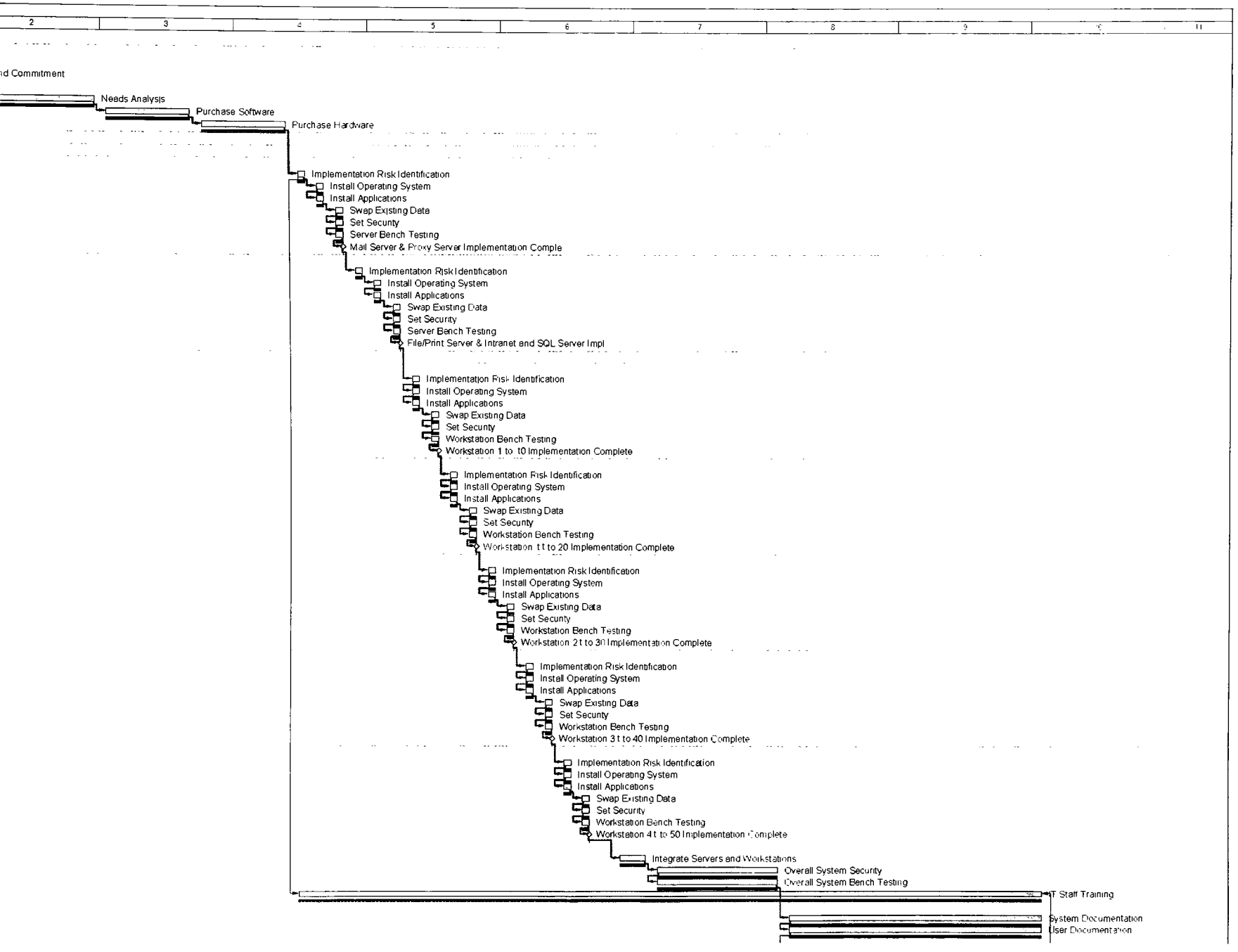
Day four, five and six are scheduled for performing the same activities on File/Print Server and Intranet and SQL Server.

The second phase is transitioning of the workstations. To make it manageable, the workstations are divided in groups of ten, and each group will take two days for transitioning. At day seven the first group of ten workstations will go through Risk identification, Installation of new operating system and applications. Day eight is scheduled for swapping existing data, setting workstation security and bench testing the workstations. After implementing on the first group of workstations the team will perform the same activities on workstations 11-20, 21-30, 31-40 and 41-50.

The next step is integrating the servers and workstations together, checking the overall security and overall testing of the system. This activity can be accomplished in the next nine days assigned in the schedule.

Once the overall system is tested, it is ready for roll out. The next 14 days are scheduled for User Training and Documentation Preparation. At the end seven additional days are scheduled to fix any bugs and to fine tune the system.

Figure 3.5 Timeline to implement the transition for A&G Associates



Analysis

4.1 A&G Associates - 50 Users

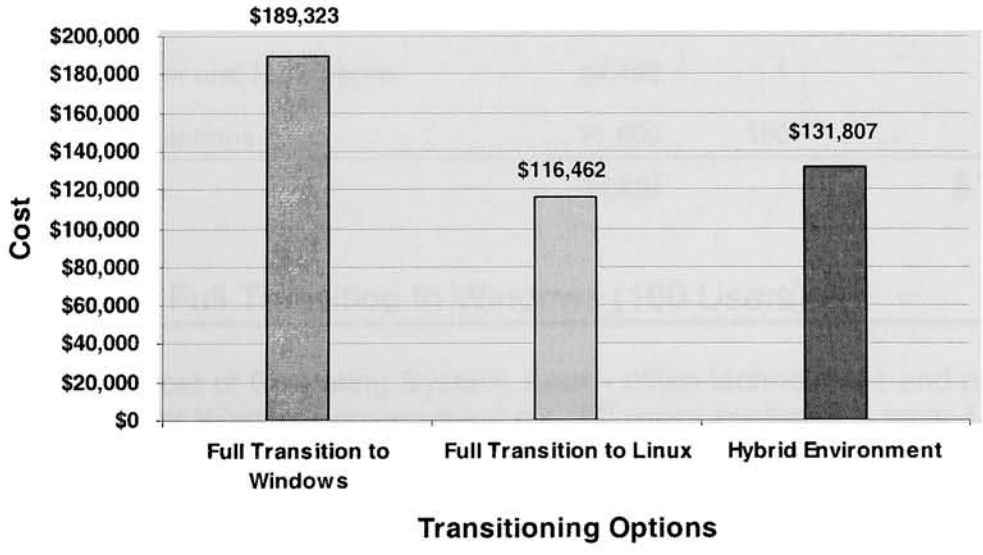
In the last section we identified alternatives and the cost associated with each one of them to transition to a new Operating System for A&G Associates the case study. Table 4.1 and Figure 4.1 summarizes the cost for each of the viable alternatives and the potential savings if A&G transitions to full Linux or undergoes a partial transition instead than transitioning to Windows.

Table 4.1 Summary of Cost to Transition for A&G Associates

Summarization (A&G Associates - 50 Users)

	Full Transition to Windows	Full Transition to Linux	Hybrid Environment (Option 5)
Total Cost	$189,323	$116,462	$131,807
Savings achieved using Linux	$0	$72,861	$57,516
% Saved using Linux over	0.00%	38.49%	30.38%

Figure 4.1 Total Cost of Transitioning



The table above summarizes the cost for the study case A&G Associates, a firm with only 50 employees, in the following subsections we will present and analyze the cost and potential savings for a firm with 100 employees and for a firm with 250 employees. These costs are presented as a preamble to an evaluation of the potential saving for a small firm with a total number of employees of 250 or less, when transitioning to a new Operating System. A firm with more than 250 employees will need to evaluate other software configurations which are not intended to be part of this document.

4.2 Small Firm - 100 Users

A firm with 100 users will most likely have 2 File/Print Servers and 1 Mail server, 1 Proxy/Firewall Server, 1 Intranet and SQL Server and 100 workstations.

Table 4.2 lists the Hardware Cost for this case study, including 5 servers and 100 staff workstations.

Table 4.2 New Hardware Cost (100 Users)

Hardware Cost (100 Users)

Type	Price/Unit	Units	Total Cost
Mail Server	$4,453	1	$4,453
Proxy / Firewall Server	$4,453	1	$4,453
File / Print Server	$4,453	2	$8,906
Intranet and SQL Server	$4,453	1	$4,453
Workstations	$1,600	100	$160,000
	Total		$182,265

4.2.1 Full Transition to Windows (100 Users)

The Cost of Operating System, back office technologies and productivity tools for Windows environment for 100 users are listed in table 4.3

Table 4.3 Software Cost Windows – Environment (100 Users)

Software Cost - Windows Environment (100 User)

Type	Price/Unit	Units	Total Cost
Microsoft Advance Server	$3,999	5	$19,995
Microsoft Internet Information Server (Web Server)	$0	2	$0
Microsoft ISA Standard Server 2004	$14,999	1	$14,999
Microsoft SQL Server	$3,999	1	$3,999
Microsoft Exchange Server 2003	$3,999	1	$3,999
Windows XP Professional Edition	$299	100	$29,900
Microsoft Office Professional	$479	100	$47,900
Internet Explorer	Free		
Additional Client Access Licenses	$67	79	$5,293
	Total		$126,085

Table 4.4 presents one year and three year cost associated with the operations of the system, mainly for professional support. The training will be for one 100 users and is a one time cost.

Table 4.4 Operating Cost - Windows Environment (100 Users)

Operating Cost - Windows Environment (100 User)

Windows 2000 Advance Server Microsoft Support			
Type	**One Year**	**Three Years**	**Comments**
Online	$198	$594	per incident
Phone	$490	$1,470	per incident
	$2,450	$7,350	for five incidents/year
Remote Advisory	$420	$1,260	per hour consulting fee
Onsite Training for Employees and IT Staff	$16,000	$16,000	80 hours at 100 per/hr
Total	$19,558	$23,350	

The total cost associated with a full transition to Windows for 100 users is summarized in Table 4.5

Table 4.5 Total Cost for Full Transition to Windows (100 Users)

Total Cost - Windows Environment (100 Users)

Category	Price
Software	$126,085
Hardware	$182,265
Operating (3 years)	$23,350
Total	$331,700

4.2.2 Full Transition to Linux (100 Users)

The Cost of Operating system, back - office technologies and productivity tools for Linux environment are listed in table 4.6

Table 4.6 Software Cost – Linux Environment (100 Users)

Software Cost - Linux Environment (100 Users)

Type	Price/Unit	Units	Total Cost
Red Hat 8.0 Professional	$150	1	$150
Apache (Web Server)	$0	1	$0
Squid	$0	1	$0
PostgreSQL (database)	$0	1	$0
Iptables (Firewall)	$0	1	$0
Sendmail or Postfix (Mail server)	$0	1	$0
GIMP (Graphics)	$0	1	$0
StarOffice (Productivity Suite)	$0	1	$0
	Total		$150

One year and three year cost for support from Red hat Linux for 100 workstations. Also, training is for 100 users

Table 4.7 Operating Cost - Linux Environment (100 users)

Operating Cost - Linux Environment (100 Users)

Desktop Red hat Linux Management Module Extension Pack			
	One Year	Three Years	Comments
Red hat 24/7 phone support			
Red hat 24/7 Web support			
Red hat One Hour phone support	$7,000.00	$21,000.00	per year
Red hat One business day Web support			
Onsite Training for Employees and IT Staff	$16,000	$16,000	80 hours at 100 per
Total	$23,000	$37,000	

The total cost associated with a full transition to Linux for 100 users is summarized in Table 4.8

Table 4.8 Total Cost for Full Transition to Linux (100 Users)

Total Cost - Linux Environment (100 Users)

Category	Price
Software	$150
Hardware	$182,265
Operating (3 years)	$37,000
Total	$219,415

4.2.3 Partial Transition (Option 5) – Hybrid Environment (100)

The Cost of Operating system, back- office technologies and productivity tools for Hybrid environment are listed in table 4.9

Table 4.9 Software Cost – Hybrid Environment (100 Users)

Software Cost - Hybrid Environment (100 Users)

Type	Price/Unit	Units	Total Cost
Red Hat 8.0 Professional	$150	1	$150
Apache (Web Server)	$0	1	$0
Squid	$0	1	$0
PostgreSQL (database)	$0	1	$0
Iptables (Firewall)	$0	1	$0
Sendmail or Postfix (Mail server)	$0	1	$0
GIMP (Graphics)	$0	1	$0
StarOffice (Productivity Suite)	$0	1	$0
Windows XP Professional Edition	$299	30	$8,970
Microsoft Office Professional	$479	30	$14,370
Internet Explorer	Free		
	Total		$23,490

Table 4.10 lists the one year and three year cost for support from Red hat Linux and Microsoft for 100 workstations. Also training is for 100 users.

Table 4.10 Operating Cost - Hybrid Environment (100 users)

Operating Cost - Hybrid Environment (100 Users)

Desktop Red hat Linux Management Module Extension Pack and Microsoft Phone Support			
	One Year	Three Years	Comments
Red hat 24/7 phone support			
Red hat 24/7 Web support			
Red hat One Hour phone support	$7,000.00	$21,000.00	per year
Red hat One business day Web support			
Microsoft Phone Support	$2,450	$7,350	for five incidents/year
Onsite Training for Employees and IT Staff	$16,000	$16,000	80 hours at 100 per
Total	$25,450	$44,350	

The total cost associated with this partial transition for 100 users is summarized in Table 4.11

Table 4.11 Total Cost for Hybrid Environment (100 Users)

Total Cost - Hybrid Environment (100 Users)

Category	Price
Software	$23,490
Hardware	$182,265
Operating (3 years)	$44,350
Total	$250,105

4.3 Small Firm - 250 Users

A firm with 250 users will most likely have the hardware configuration of 5 File/Print Servers and 1 Mail server, 1 Proxy/Firewall Server, 1 Intranet and SQL Server and 250 workstations.

Table 4.12 lists the Hardware Cost for this case study, including 9 servers and 250 staff workstations.

Table 4.12 New Hardware Cost (250 Users)

Hardware Cost (250 Users)

Type	Price/Unit	Units	Total Cost
Mail Server	$4,453	1	$4,453
Proxy / Firewall Server	$4,453	1	$4,453
File / Print Server	$4,453	5	$22,265
Intranet and SQL Server	$4,453	1	$4,453
Workstations	$1,600	250	$400,000
	Total		$435,624

4.3.1 Full Transition to Windows (250 Users)

The Cost of Operating System, back - office technologies and productivity tools for Windows environment for 250 users are listed in table 4.13

Table 4.13 Software Cost Windows – Environment (250 Users)

Software Cost - Windows Environment (250 User)

Type	Price/Unit	Units	Total Cost
Microsoft Advance Server	$3,999	8	$31,992
Microsoft Internet Information Server (Web Server)	$0	2	$0
Microsoft ISA Standard Server 2004	$14,999	1	$14,999
Microsoft SQL Server	$3,999	1	$3,999
Microsoft Exchange Server 2003	$3,999	1	$3,999
Windows XP Professional Edition	$299	250	$74,750
Microsoft Office Professional	$479	250	$119,750
Internet Explorer	Free		
Additional Client Access Licenses	$67	229	$15,343
	Total		$264,832

Table 4.14 presents one year and three year cost associated with the operations of the system, mainly for professional support. The training in this case will be for will be for 250 users.

Table 4.14 Operating Cost - Windows Environment (250 Users)

Operating Cost - Windows Environment (250 Users)

Windows 2000 Advance Server Microsoft Support			
Type	One Year	Three Years	Comments
Online	$495	$1,485	per incident
Phone	$1,225	$3,675	per incident
	$6,125	$18,375	for five incidents/year
Remote Advisory	$1,050	$3,150	per hour consulting fee
Onsite Training for Employees and IT Staff	$40,000	$40,000	80 hours at 100 per/hr
Total	$48,895	$58,375	

The total cost associated with a full transition to Windows for 250 users is summarized in Table 4.15

Table 4.15 Total Cost for Full Transition to Windows (250 Users)

Total Cost - Windows Environment (250 Users)

Category	Price
Software	$264,832
Hardware	$435,624
Operating (3 years)	$58,375
Total	$758,831

4.3.2 Full Transition to Linux (250 Users)

The Cost of Operating system, back - office technologies and productivity tools for Linux environment are listed in table 4.16

Table 4.16 Software Cost – Linux Environment (250 Users)

Software Cost - Linux Environment (250 Users)

Type	Price/Unit	Units	Total Cost
Red Hat 8.0 Professional	$150	1	$150
Apache (Web Server)	$0	1	$0
Squid	$0	1	$0
PostgreSQL (database)	$0	1	$0
Iptables (Firewall)	$0	1	$0
Sendmail or Postfix (Mail server)	$0	1	$0
GIMP (Graphics)	$0	1	$0
StarOffice (Productivity Suite)	$0	1	$0
	Total		$150

Table 4.17 lists the one year and three year cost for support from Red hat Linux for 250 workstations. Also, training is for 250 users

Table 4.17 Operating Cost - Linux Environment (250 users)

Operating Cost - Linux Environment (250 Users)

Desktop Red hat Linux Management Module Extension Pack			
	One Year	Three Years	Comments
Red hat 24/7 phone support Red hat 24/7 Web support Red hat One Hour phone support Red hat One business day Web support	$17,500.00	$52,500.00	per year
Onsite Training for Employees and IT Staff	$40,000	$40,000	80 hours at 100 per
Total	$57,500	$92,500	

The total cost associated with a full transition to Linux for 250 users is summarized in Table 4.18

Table 4.18 Total Cost for Full Transition to Linux (250 Users)

Total Cost - Linux Environment (250 Users)

Category	Price
Software	$150
Hardware	$435,624
Operating (3 years)	$92,500
Total	$528,274

4.3.3 Partial Transition (Option 5) – Hybrid Environment (250)

The Cost of Operating system, back - office technologies and productivity tools for Hybrid environment are listed in table 4.19

Table 4.19 Software Cost – Hybrid Environment (250 Users)

Software Cost - Hybrid Environment (250 Users)

Type	Price/Unit	Units	Total Cost
Red Hat 8.0 Professional	$150	1	$150
Apache (Web Server)	$0	1	$0
Squid	$0	1	$0
PostgreSQL (database)	$0	1	$0
Iptables (Firewall)	$0	1	$0
Sendmail or Postfix (Mail server)	$0	1	$0
GIMP (Graphics)	$0	1	$0
StarOffice (Productivity Suite)	$0	1	$0
Windows XP Professional Edition	$299	75	$22,425
Microsoft Office Professional	$479	75	$35,925
Internet Explorer	Free		
	Total		$58,500

Table 4.20 lists the yearly cost for support from Red hat Linux and Microsoft for 250 workstations. Also training is for 250 users.

Table 4.20 Operating Cost - Hybrid Environment (250 users)

Operating Cost - Hybrid Environment (250 Users)

Desktop Red hat Linux Management Module Extension Pack and Microsoft Phone Support			
	One Year	Three Years	Comments
Red hat 24/7 phone support			
Red hat 24/7 Web support			
Red hat One Hour phone support	$17,500.00	$52,500.00	per year
Red hat One business day Web support			
Microsoft Phone Support	$6,125	$18,375	for five incidents/year
Onsite Training for Employees and IT Staff	$40,000	$40,000	80 hours at 100 per
Total	$63,625	$110,875	

The total cost associated with a full transition to Linux for 250 users is summarized in Table 4.21

Table 4.21 Total Cost for Hybrid Environment (250 Users)

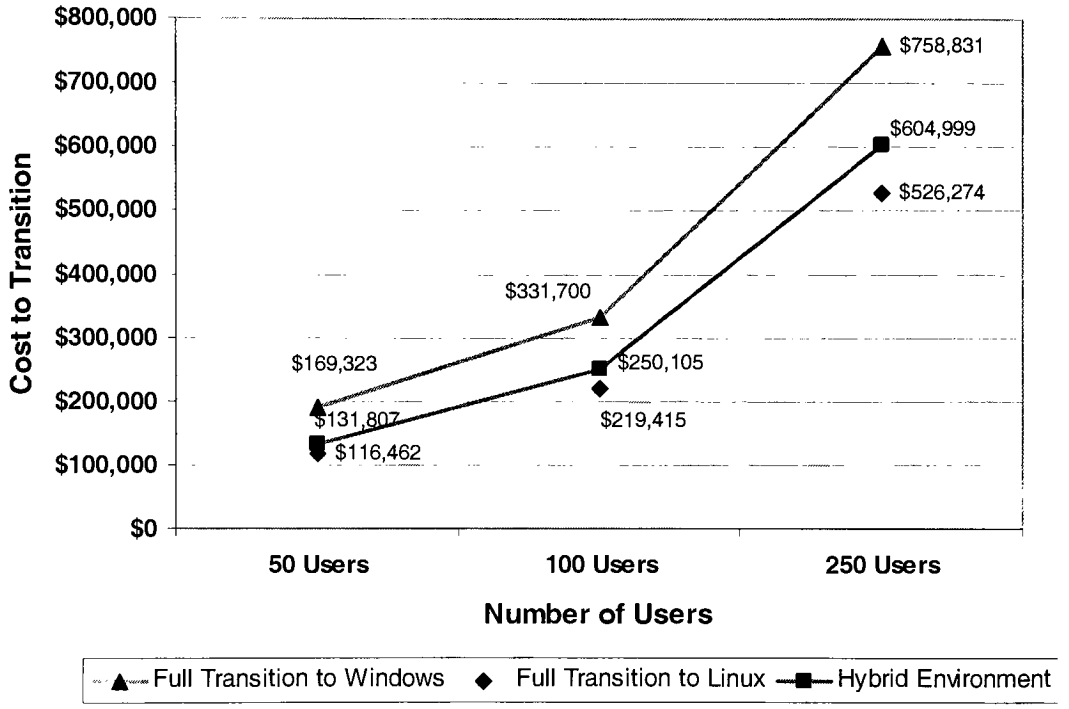
Total Cost - Hybrid Environment (250 Users)

Category	Price
Software	$58,500
Hardware	$435,624
Operating (3 years)	$110,875
Total	$604,999

4.4 Cost Comparison for 50, 100 and 250 employee Firm

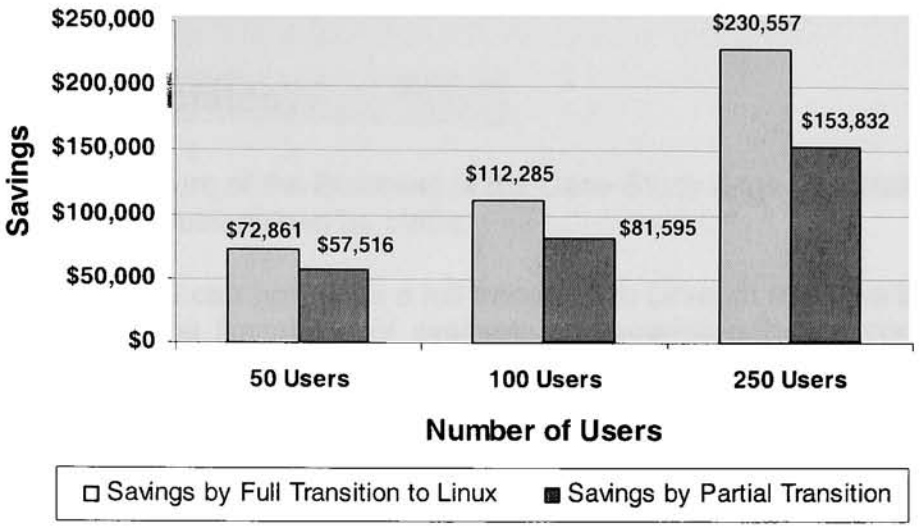
Figures 4.2 and 4.3 present the cost and potential savings for the transitioning of the Operating System for a Firm with 50, 100 and 250 employees for the three alternatives presented in previous sections.

Figure 4.2 Cost to Transition to Windows, Linux or Hybrid Environment



From the graph above we can estimate the opportunity for cost savings for each case. Therefore for a firm with 50 employees the potential savings are ranging from 58 to 73 thousand dollars depending on the type of transition, the figure below will present the saving for each one of the 50, 100 and 250 employee cases.

Figure 4.3 Savings by Transitioning to Linux



Conclusions

5.1 A&G Associates

Due to the nature of the Business of the Case Study A&G Associates, the following conclusions can be made:

- A&G can not make a full transition to Linux at this time because of the limitations of available engineering software compatible with Linux. Examples of these software limitations includes: Water Distribution Network Analysis or Sewer Collection Modeling.
- A&G can only make a Hybrid Transition to Linux provided that some workstations are windows based to run the engineering applications.
- A&G shall maintain the minimum number of workstations running windows to make the cost savings of transitioning attractive to management.
- A&G's total cost of transitioning under Partial Transition Option 5 is approximately $ 132,000. With approximately $ 12,000 dollars in software and $ 98,000 in hardware, the remaining cost is associated with operating the system.
- A&G's total cost savings of transitioning under Partial Transition Option 5 compared to full Windows Transition total approximately $ 58,000 dollars. This savings are equivalent to approximately 20% of the profit for the firm in one year. This is based on the assumption that the firm needs approximately $ 100,000 in revenues for each employee and that the firm operates at approximately a 6.0% profit.
- A&G will need to closely look at the mode of payment for the implementation of a transitioning of Operating System, particularly in the case of a need to borrow money to complete this project. A small firm can be cash flow short to implement such a program. Therefore the firm needs to clearly understand the financial and operations risks associated when making this transitioning.

5.2 Firms with more than 50 but less than 250 employees

From the cost tables presented in the previous section for an engineering firm with 50,100 or 250 employees, we visualize the relationship between the cost and potential savings that can be accomplished by implementing a Partial Transition to Linux under Option 5. A firm with a number of employees between 50 and 250 can use this relationship to interpolate between the data to estimate the cost and potential savings involved by implementing a transitioning to a Linux Operating System.

The following conclusions can be made from the previous section:

- A firm with 100 employees will have a total cost of transitioning under Partial Transition Option 5 of approximately $ 250,000. With approximately $ 24,000 dollars in software and $ 182,000 in hardware, the remaining cost is associated with operating the system.
- A firm with 100 employees will have a potential cost savings of transitioning under Partial Transition Option 5 (compared to full Windows Transition) of approximately $ 82,000 dollars. This savings are equivalent to approximately 14% of the profit for the firm in one year. This is based on the assumption that the firm needs approximately $ 100,000 in revenues for each employee and that the firm operates at approximately a 6.0% profit.
- Correspondingly a firm with 250 employees has a total cost of transitioning under Partial Transition Option 5 of approximately $ 605,000. With approximately $ 59,000 dollars in software and $ 436,000 in hardware, the remaining cost is associated with operating the system.
- The savings for a firm with 250 employees undergoing Partial Transition Option 5 (compared to full Windows Transition) are approximately $ 154,000 dollars. This savings are equivalent to approximately 10% of the profit for the firm in one year. This is based on the assumption that the firm needs approximately $ 100,000 in revenues for each employee and that the firm operates at approximately a 6.0% profit.

Recommendations

6.1 Recommendations to A&G Associates

Based on the cost analysis presented in Section 4 and the conclusions from Section 5, we can make the following recommendations to A&G Associates:

- A&G Associates shall make a transition to Linux but shall upgrade some workstations to Windows XP Environment in order to maintain the capability to run engineering applications in accordance with Partial transition Option 5, presented in Section 4.
- Implementation of Partial Transition Option 5 will promote cost savings of approximately $ 58,000 during the Transition to a new Operating System.
- Due to the limitation of IT support staff, it is recommended that initially A&G purchases outside support services from Red hat Linux or other third party providers. This will reduce the downtime in case an emergency arises. This support services can be reduced when the IT staff becomes comfortable with the over all system.
- It is recommended that A&G does make major changes to the code, this will mitigate the risks.
- With a new operating system in place initially users will have many questions on a daily basis. A&G should identify an in house support team in addition to the IT staff and outside services.

6.2 General Recommendations

From this document we can arrive to the following general recommendations for non engineering small firms with the equivalent number of employees:

- To estimate the cost of a transition to an upgraded Operating System and the potential saving between Windows and Linux environments the firm may use the data provided in Section 4 and may interpolate in between the given data.

- The maximum cost savings will be achieved by fully transitioning to a Linux Environment, noting that the data cost savings provided were calculated for firms with a number of employees between 50 and 250. Above this number of employees other software and hardware criteria will need to be fully evaluated to determine the actual cost of transitioning to Linux environment.
- A firm transitioning to Linux should plan in advance before they start the migration. It is important that the firm has a risk evaluation team to evaluate downtime and financial risks.
- As explained before Firms should avoid changing the code. If there is a necessity of changing the code it should be made sure that there is a change management process with a change management board approving the requests. All the changes made to the code should be documented for future references.
- Firms migrating should form a Linux advisory group consisting of stakeholders. This group should include representatives from IT, legal, internal audit and outside vendor expert in this field. Advisory group will be responsible for internal development, testing, change management and training the staff.

Appendices

Appendix A: Server Specification for A&G Associates

Dell PowerEdge 2800

Date & Time: November 23, 2004

SYSTEM COMPONENTS

Module	Description	Product Code	Sku	Id
PowerEdge 2800	FREE UPGRADE to Intel® Xeon™ processor at 3.0GHz/1MB Cache	FR28030	[463-3617]	1
Operating System	No Operating System	NOOSM	[420-4077]	11
Additional Processor	Single Processor only	1P	[311-1193]	2
Memory	4GB DDR2 400MHz (2X2GB), Dual Ranked DIMMs	4G2D4D	[311-3593]	3
Keyboard	Standard Windows Keyboard,Gray	S	[310-1676]	4
Monitor	Dell E773 Monitor, 17 inch (16.0 Inch Viewable), Gray	E773S	[320-2907]	5
Primary Hard Drive	146GB 10K RPM Ultra 320 SCSI Hard Drive	146G103	[341-1288]	8
Floppy Drive	No Floppy Drive	NFD	[341-0838]	10
Mouse	Logitech PS/2 2-button Mouse with Scroll	L2M	[310-4405]	12
Network Adapter	Onboard NICS	OBNICS	[430-8991]	13
CD/DVD Drive	8X DVD-ROM	8XDVD	[313-2691]	16
Bezel	Active ID Bezel Option for Tower Configuration	TBEZEL	[313-2699]	17
Hard Drive Backplane	1x8 Hot Plug SCSI Hard Drive Backplane	1X8BKPL	[311-4283]	18
Documentation	Electronic Documentation and OpenManage CD Kit	EDOCS	[310-5476]	21
Hard Drive Configuration	Drives attached to embedded SCSI controller, No RAID	MSN	[341-1324]	27
Chassis Configuration	Tower Chassis Orientation	TOWER	[310-5467]	28
Hardware Support Services	3Yr BRONZE Support, Next Business Day Onsite	BRONZEW	[960-1305][902-8090][902-7072]	29
Installation Support Services	No Installation Assessment	NOINSTL	[900-9997]	32
Power Supply	Non-Redundant Power Supply	NRPS	[310-5553]	36
Technical Sales Representative Contact	Yes	TSRYES	[462-9388]	192

TOTAL: $4,453.00

Note: Price is for one PowerEdge 2800 server and includes taxes, shipping and handling.

Appendix B: Workstations Specification for A&G Associates

Dell Precision Workstation 370

Date & Time: November 23, 2004

SYSTEM COMPONENTS

Module	Description	Product Code	Sku	Id
Dell Precision Workstation 370 Minitower	Intel® Pentium® 4 Processor 2.80GHz, 1MB/800	328T1	[221-4923]	1
Memory	1GB, 400MHz, DDR2 SDRAM Memory, NECC (2 DIMMS)	1GN2	[310-5305]	3
Keyboard	Entry Level, USB, No Hot Keys	U	[320-3811]	4
Monitors	Dell 17 inch UltraSharp™ 1703FP Flat Panel, adjustable stand, VGA/DVI	1703FPH	[320-5698]	5
Graphics Card	64MB PCIe x16 nVidia Quadro NVS 280, Dual VGA Capable	NV64V	[312-0263]	6
Boot Hard Drive	40GB SATA, 7200 RPM Hard Drive without RAID	40SAT	[341-0510]	8
Hard Drive Configuration	C1 All SATA drives, Non-RAID, 1 or 2 drive total configuration	SATA12	[341-1259]	9
Floppy Drive Options	3.5 inch 1.44MB Floppy Drive	FD	[341-0497]	10
Mouse	Dell USB 2-Button Optical Mouse with Scroll	LOD	[310-4165]	12
File System	NTFS File System	NTFS	[420-3699]	13
CD-ROM, DVD, and Read-Write Devices	48X/32X CD-RW/DVD Combo w/ CyberLink PowerDVD	COMBO	[341-0476]	16
Speakers	Dell Two Piece Stereo System	A215	[313-2753]	18
Resource CD	Resources CD contains Diagnostics and Driver for Precision Systems	RCD	[310-5419]	21
Productivity Software	Dell Precision Workstation	NOMSBE	[461-2963]	22
Hardware Support Services	3 Year Basic Plan	W3YOS	[980-7000][980-7002]	29
Onsite System Setup	No Onsite System Setup	NOINSTL	[900-9987]	32
Quick Reference Guide	Quick Reference Guide	REF	[310-5428]	40
Mail- In Rebate	None	NONE	[463-1832]	81

TOTAL: $1,600.00

Note: Price is for one Dell Precision Workstation 370 and includes taxes, shipping and handling.

Appendix C: Software cross-reference between Windows & Linux

Below table lists the cross reference between windows and Linux software as applicable to A&G Associates and similar firms. A complete list of software is available on:

http://linuxshop.ru/linuxbegin/win-lin-soft-en/table.shtml#2

Description of the program,	Windows	Linux
Networking.		
Web browser	Internet Explorer, Netscape / Mozilla, Opera [Prop], Firebird, ...	1) Netscape / Mozilla. 2) Galeon. 3) Konqueror. 4) Opera. [Prop] 5) Firebird. 6) Nautilus. 7) Epiphany. 8) Links. (with "-g" key). 9) Dillo. (Russian language patches - here). 10) Encompass.
Email client	Outlook Express, Netscape / Mozilla , The Bat, Eudora, Becky, Datula, Sylpheed / Sylpheed-claws, Opera	1) Evolution. 2) Netscape / Mozilla messenger. 3) Sylpheed / Sylpheed-claws. 4) Kmail. 5) Gnus. 6) Balsa. 7) Bynari Insight GroupWare Suite. [Prop] 8) Arrow. 9) Gnumail. 10) Althea. 11) Liamail. 12) Aethera. 13) MailWarrior. 14) Opera.
Address book	Outlook	1) Rubrica
FTP-clients	Bullet Proof FTP, CuteFTP, WSFTP, SmartFTP, FileZilla, ...	1) Gftp. 2) Konqueror. 3) KBear. 4) IglooFTP. [Prop] 5) Nftp. 6) Wxftp. 7) AxyFTP. 8) mc. (cd ftp://...)

		9) tkFTP. 10) Yafc. 11) Dpsftp. (dead project)
Video/audio conference	NetMeeting	1) GnomeMeeting. 2) vat/vic/wb. 3) rat/wbd/nte. 4) NeVoT. 5) IVS.
Firewall (packet filtering)	BlackICE, ATGuard, ZoneAlarm, Agnitum Outpost Firewall, WinRoute Pro, Norton Internet Security, Sygate Personal Firewall PRO, Kerio Personal Firewall, ...	iptables or more outdated ipchains (console, standard). Front ends: 1) Kmyfirewall. 2) Easy Firewall Generator. 3) Firewall Builder. 4) Shorewall. 5) Guarddog. 6) FireStarter. 7) Smoothwall. [Prop] 8) IPCop. 9) Zorp.
	Windows Domain, Active Directory	1) Samba. 2) Ldap. 3) yp.

Desktop / System software.

Text editor	Notepad, WordPad, TextPad, Vim, Xemacs, ...	1) Kedit (KDE). 2) Gedit (Gnome). 3) Gnotepad. 4) Kate (KDE). 5) KWrite (KDE). 6) Nedit. 7) Vim. 8) Xemacs. 9) Xcoral. 10) Nvi. 11) Ozeditor.
Viewing PDF	1) Adobe Acrobat Distiller 2) GhostView	1) Acrobat Reader. [Prop] 2) Xpdf. 3) GV. 4) GGV. 5) GhostView. 6) Kghostview.
Creating PDF	1) Adobe Acrobat Distiller 2) GhostView 3) Ghostscript	1) Any Linux WYSIWYG program -> print to file -> ps2pdf. (Here's an article about this). 2) Adobe Acrobat Distiller. [Prop] 3) PStill. [Shareware] 4) PDFLatex. 5) Xfig. 6) Ghostscript.

		7) Tex2Pdf. 8) Reportlab. 9) GV. 10) GGV. 11) GhostView. 12) Kghostview. 13) Panda PDF Generator.
Text recognition (OCR)	Recognita, FineReader	1) ClaraOcr. 2) Gocr. 3) Kooka.
Antivirus	AVG AntiVirus, NAV, Dr. Web, TrendMicro, F-Prot, Kaspersky, ...	1) Dr. Web. [Prop] 2) Trend ServerProtect. [Prop] 3) RAV Antivirus. [Prop] (Bought by Microsoft) 4) OpenAntivirus + AMaViS / VirusHammer. 5) F-Prot. [Prop] 6) Sophie / Trophie. 7) Clam Antivirus. 8) Kaspersky. [Prop] 9) YAVR.
Machine mirroring over network	1) ImageCast 2) Norton Ghost	1) UDP Cast. 2) Techteam's UDP Cast Disks. 3) Ghost for Unix (g4u).
Work with Palm	Palm Desktop	1) Kpilot. 2) Jpilot.
Multimedia (audio / CD).		
Music / mp3 / ogg players	1) Winamp 2) Zinf 3) SnackAmp 4) Soritong 5) Apollo 6) K-jofol 2000 7) Sonique 8) C-4 9) Media Box Audio / Video Workstation 5 10) Blaze Media Pro 11) NEX 3 12) Real Jukebox 13) Windows Media Player	1) XMMS (X multimedia system). 2) Noatun. 3) Zinf. (former Freeamp) 4) Winamp. 5) Xamp. 6) GQmpeg. 7) SnackAmp. 8) Mplayer. (Frontend: Kplayer). 9) Xine. (Frontends: Sinek, Totem)
Programs for CD burning with GUI	Nero, Roxio Easy CD Creator, ...	1) K3b. (KDE) 2) XCDRoast. 3) KOnCd. 4) Eclipt Roaster. 5) Gnome Toaster. 6) CD Bake Oven. 7) KreateCD.

		8) SimpleCDR-X. 9) GCombust. 10) WebCDWriter. (CD burn server, usable from any remote browser with Java support) 11) CDR Toaster. 12) Arson. 13) CD-Me (Creation of audio-CD).
CD player	CD player, Winamp, Windows Media Player, ...	1) KsCD. 2) Gtcd (Gnome) + tcd (console). 3) Orpheus. (console) 4) Sadp. 5) WorkMan. 6) Xmcd. 7) Grip. 8) XPlayCD. 9) ccd / cccd. (console) 10) cdp. (console) 11) BeboCD.
Multimedia (graphics).		
	1) ACDSee 2) IrfanView 3) Xnview 4) CompuPic [Prop] 5) Windows Fax and Image viewer 5) Any web browser	1) Xnview. 2) GQview. 3) Qiv. 4) CompuPic [Prop] 5) Kuickshow. 6) Kview. 7) GTKSee. 8) xv. [Prop] 9) pornview. 10) imgv. 11) Gwenview. 12) Gliv. 13) Showimg. 14) Fbi. 15) Gthumb. 16) PixiePlus. 17) Electric Eyes (Gnome). 18) Eye of Gnome. 19) GImageView. 20) Hugues Image Viewer.
Graphic files viewer		21) Any web browser.
		1) Kpaint. 2) Tuxpaint. 3) Xpaint. 4) Gpaint. 5) Killustrator.
Simple graphic editor	Paint	6) Graphtool.
Powerful graphic editor in	1) Adobe Photoshop [Prop]	1) Gimp.

PhotoShop style	2) Gimp 3) Paint Shop Pro [Prop] 4) Pixel32 [Prop] 5) Corel PhotoPaint [Prop] 6) Macromedia Fireworks	2) ImageMagick. 3) Pixel32. [Prop] 4) CinePaint. 5) RubyMagick. 6) Corel PhotoPaint 9. [Prop]
Programs for work with vector graphics	Adobe Illustrator, Corel Draw, Freehand, AutoSketch, OpenOffice Draw	1) Sodipodi. 2) xfig. 3) Sketch. 4) Karbon14 and Kontour. 5) OpenOffice Draw. 6) Dia. 7) Tgif. 8) Gestalter. 9) ImPress. 10) Tkpaint. 11) Tgif. 12) Corel Draw 9. [Prop]
3D-graphics	3D Studio MAX, Maya [Prop], Povray, ...	1) Blender. 2) Maya. [Prop] 3) KPovModeler. 4) K3Studio. 5) Moonlight. 6) GIG3DGO. 7) Povray. 8) MegaPov. 9) K3D. 10) Wings 3D. 11) Softimage XSI. [Prop] 12) Kludge3d.
Multimedia (video and other)		
Video / mpeg4 players	1) BSplayer 2) Zoomplayer 3) Windows Media Player 4) VideoLAN 5) Winamp3 6) Mplayer 7) RealPlayer 8) Xing 9) Simplayer	1) Mplayer. (Frontend: Kplayer). (LiveCD distribution of Mplayer - MoviX). 2) Xine. (Frontends: Sinek, Totem) 3) VideoLAN. 4) Aviplay. 5) Winamp3. 6) Noatun. 7) KDE Media Player. 8) XMovie. 9) Kaboodle. 10) MpegTV. 11) Avifile. 12) Xmps. 13) Ogg Tarkin. 14) Theora.
DVD players	PowerDVD, WinDVD, MicroDVD, Windows Media Player, VideoLAN	1) Ogle. 2) Mplayer.

		3) Xine. 4) Aviplay. 5) VideoLAN. 6) OMS.
DVD rippers / encoders	Gordian Knot, Mencoder (from Mplayer)	1) Drip. 2) Transcode. 3) Mencoder. (from Mplayer) 4) Ffmpeg. 5) DVD::Rip.
Simple video creation and editing	Windows Movie Maker	1) iMira Editing. [Prop] 2) MainActor. [Prop] 3) Broadcast 2000. 4) Avidemux.
Office/business.		
Office suite	MS Office, StarOffice / OpenOffice, 602Software	1) OpenOffice. 2) StarOffice. [Prop] 3) Koffice. 4) HancomOffice. [Prop] 5) Gnome Office. 6) Applixware Office. [Prop] 7) Siag Office. 8) TeX, LaTeX, ...
Office suite	WordPerfect Office 2000	WordPerfect Office 2000 for Linux. (No longer available at Corel website. It was Windows version, running under Wine :).
Word processor	Word, StarOffice / OpenOffice Writer, 602Text, Abiword	1) Abiword. 2) TextMaker [Prop] 3) WordPerfect. 4) Ted. 5) StarOffice / OpenOffice Writer. 6) Kword. 7) LyX. 8) Kile (KDE Integrated LaTeX Environment).
Spreadsheets	Excel, StarOffice / OpenOffice Calc, 602Tab	1) Gnumeric. 2) Abacus. 3) StarOffice / OpenOffice Calc. 4) Kspread.
Graphing / charting data	Excel, MicroCall Origin, ...	1) Kivio. 2) Dia. 3) KChart. 4) xfig. 5) Gnuplot. 6) GtkGraph. 7) GNU Plotutils. 8) Ploticus.
Creating presentations	MS PowerPoint, StarOffice	1) StarOffice Presentation.

	Presentation, OpenOffice Impress	2) OpenOffice Impress. 3) Kpresenter. 4) MagicPoint. 5) Kuickshow & gimp :).
Local database	MS Access, InterBase6, OpenOffice + MySQL.	1) KNoda. 2) Gnome DB Manager. 3) OpenOffice + MySQL. 4) InterBase7. [Prop] 5) InterBase6. 6) Berkley DB. 7) Rekall. [Prop] 8) StarOffice Adabase.
Personal finances manager	1) MS Money 2) Quicken 3) Moneydance [Prop]	1) GNUcash. 2) GnoFin. 3) Kmymoney. 4) Grisbi. 5) Moneydance. [Prop]
Project management	MS Project, Project Expert 7	1) Mr Project. 2) Outreach.
Financial accounting package (global)		1) Hansa Business Solutions. [Prop] 2) Quickbooks.
Server software.		
Web-server	1) Apache 2) IIS 3) Roxen 4) wn 5) cern-httpd 6) dhttpd 7) caudium 8) aolserver 9) Boa	1) Apache. 2) Xitami. 3) Thttp. 4) TUX (Red Hat Content Accelerator). 5) PublicFile. 6) Boa. 7) Caudium. 8) Roxen. 9) Zeus. [Prop] 10) Thy.
FTP-server	Internet Information Server, ServU, War FTP, BulletProof FTP server, FileZilla server, ...	1) pure-ftpd. 2) vsftpd. 3) wu-ftpd. 4) proftpd. 5) gl-ftpd. 6) ftp. 7) PublicFile. 8) Teepeedee.
Database engine	MS SQL, MySQL	1) Sybase Adaptive Server Enterprise. [Prop] 2) PostgreSQL. The most advanced open source database. 3) MySQL. The most popular open source database. 4) mSQL. 5) SAP DB.

Database engine	IBM DB2	IBM DB2. [Prop]
Database engine	Oracle	1) Oracle. [Prop] 2) PostgreSQL. 3) Linter. (cyrillic)
Database engine	Informix [Prop]	Informix. [Prop]
Database engine	Borland Interbase, FireBird	FireBird.
Email server	MDaemon, Hamster	1) Sendmail. 2) Qmail. 3) Postfix. 4) Exim.
Email / PIM / Groupware server	Microsoft Exchange	1) CommuniGate Pro. [Prop] 2) Bynari's Insight GroupWare Suite. [Prop] 3) Samsung Contact. [Prop] 4) Teamware Office. [Prop] 5) Novell Netmail. [Prop] 6) Amphora. (Zope / Qmail). 7) Tutos. (Apache / PHP / Mysql / Sendmail). 8) Kroupware. The project from the KDE PIM developers, which is being financed by the government of Germany. 9) SuSe Linux Openexchange Server. [Prop] 10) PHPGroupware. 11) SCOoffice Mail Server. [Prop] (SCO - m.d. :). 12) LinuXchangE. 13) OpenOffice.org Groupware Project. (New!) 14) Tiki CMS/Groupware. (Apache / PHP / Mysql).
Proxy server	MS Proxy Server, WinGate	1) Squid. 2) Paco. 3) Privoxy. 4) Wwwoffle. 5) OOPS.
Server for supporting Java Servlets and JSP, can work with Apache	Tomcat	Tomcat.
Scientific and special programs.		
Programs for three-dimensional modeling	SolidWorks, ...	ProEngineer Linux. [Prop]
Programs for three-dimensional modeling	CATIA	CATIA. It was designed under Unix, and from version 4 (2000) it was ported under Windows (not too successfully).

Programs for three-dimensional modeling	SolidEdge	SolidEdge (part of more powerful package Unigraphics).
Engineering	ANSYS	ANSYS.
		1) Varkon.
		2) Linuxcad. [Prop, ~100$]
		3) Varicad. [Prop]
		4) Cycas. [Prop]
		5) Tomcad.
		6) Thancad.
		7) Fandango (alpha-version).
		8) Lignumcad.
		9) Giram.
		10) Jcad.
		11) QSCad.
		12) FreeEngineer.
		13) Ocadis.
		14) PythonCAD.
CAD/CAM/CAE	AutoCAD, Microstation, ArchiCAD	15) OpenCascade.
CAD/CAM/CAE, simplified	AutoCAD Lite	Qcad.
Desktop Publishing Systems	Adobe PageMaker, QuarkXPress	Adobe Framemaker. [Proprietary, cancelled]
		1) Scribus - Desktop Publishing for Linux.
Small desktop publishing systems	MS Publisher	2) KWord.
		1) Kivio (Koffice).
		2) Dia.
		3) KChart.
		4) xfig.
		5) Tgif + dotty.
		6) Tulip.
		7) Poseidon for UML. [Prop & free versions]
Diagram and chart designer	Microsoft Visio	8) JGraph + JGraphPad. (Java)
		All projects: FreeGIS Project.
		1) Grass.
		2) Quantum GIS.
		3) PostGIS.
		4) FreeGIS.
GIS (Geographical information system)	ArcView	5) MapQuest.
		6) MapBlast.
Finity Element Analysis	-	1) FELT (Finity Element Analysis)

Bibliography/References

Books

1. Allen David, Lahti Christian, **Windows to Linux Migration Toolkit**, Syngress, October 1, 2004

2. Easttom Chuck, Moving from windows to Linux, Charles River Media, December 30, 2003

3. Gagne Marcel, **Moving to Linux**, Addison-Wesley Professional, August 7, 2003

4. Welsh Matt, Kaufman Lar, Dalheimer Matthias Kalle, Dawson Terry, **Running Linux**, O'Reilly, 4 edition December 15, 2002

5. Banahan Mike, Boerner Michael, **Professional Linux Deployment**, Wrox Press Inc, 1st edition January, 2000

6. Bradford Ed, Mauget Lou, **Linux and Windows Interoperability Guide**, Prentice Hall PTR, Dec 14, 2001

Articles and Web References

http://linuxshop.ru/linuxbegin/win-lin-soft-en/table.shtml#2

Chapman Mark Chapman, **Linux questions and answers**, July 7, 2000, ftp://www6.software.ibm.com/software/developer/library/l-faq.pdf

Horowitz Michael, **Linux vs. Windows**, September 2002 http://www.michaelhorowitz.com/Linux.vs.Windows.html, October 29, 2004

http://arts.bev.net/roperldavid/LinWinComp.htm

http://www.autarkis.co.uk/academic/linux_in_retail.html

http://librenix.com/?inode=1709

http://techupdate.zdnet.com/techupdate/stories/main/0,14179,2907876,00.html

http://www.linux-tutorial.info/Linux-NT_Debate/

http://www.accpac.com/redhat.asp

http://www.zetetics.com/mac/blog/00000312.html

http://www.asiacomputerweekly.com/acw_ViewArt.cfm?Artid=18085&catid=6&subcat=58

http://www.linuxworld.com/story/46861.htm

http://www.entmag.com/news/article.asp?EditorialsID=5910

http://software-engineering.engineering.designerz.com/software-for-engineering-finite-element-analysis.php

http://www.forbes.com/technology/enterprisetech/2004/08/31/cz_dl_0831msft.html

http://www.aei-brookings.org/admin/authorpdfs/page.php?id=261

http://www.oetrends.com/archive.php?action=view_record&idnum=150

http://www.worldtechtribune.com/worldtechtribune/asparticles/buzz/bz12042002.asp

http://www.datasync.com/~rogerspl/Advocacy-HOWTO.html

http://mtechit.com/linux-biz/business_services/

http://www.linuxinsider.com/story/32844.html

http://www.icewalkers.com/opd/Business/Energy_and_Environment/Utilities/Software/

http://linux.maruhn.com/directory.html

http://www.linux.ie/newusers/alternatives.php

http://www.ntlug.org/~cbbrowne/financelinux.html

http://mtechit.com/linux-biz/automotive_industry/daimlerchrysler.html

http://mtechit.com/linux-biz/oil_and_gas/giant.html

http://mtechit.com/linux-biz/oil_and_gas/postsk.html

http://www.linuxtek.com/whylinux/

http://www.theinquirer.net/?article=13575

http://www.8networks.co.uk/cost/MicrosoftTCOAnalysis.html

http://www.8networks.co.uk/cost/linux.html

http://web.mit.edu/ist/topics/linux/equivalents.html

http://www.newsfactor.com/perl/story/22080.html

http://www.novell.com/linux/truth/better_choice.html

http://myvillage.8m.com/office.html

http://www.planetarium.com.br/planetarium/noticias/2003/2/1046459036

http://www.eweek.com/article2/0,3959,741723,00.asp

http://linuxgazette.com/node/view/386

http://linuxshop.ru/linuxbegin/win-lin-soft-en/table.shtml#2

http://searchenterpriselinux.techtarget.com/qna/0,289202,sid39_gci883142,00.html

http://www.winehq.org/site/supported_applications

http://www.yellowbugcomputers.com/techdocs/winlin.html

http://www.dell.com

http://techupdate.zdnet.com/techupdate/stories/main/0,14179,2809945,00.html

http://www.theregister.co.uk/content/4/18002.html

http://www.internetweek.com/newslead01/lead032901.htm

http://www.troubleshooters.com/tpromag/200104/200104.htm

http://techupdate.zdnet.com/techupdate/stories/main/0,14179,2809945,00.html

http://www.desktoplinux.com/articles/AT5035096600.html

http://techrepublic.com.com/5100-6296-1059134-3.html

http://computing-dictionary.thefreedictionary.com

http://www.internetnews.com/stats/article.php/2205811